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A Simulation-Based Evaluation of a Force Protection System: Soldier Performance, Training Requirements, and Soldier-Machine Interface Considerations

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This soldier-in-the-loop evaluation, part of Tank Automotive Research, Development, and Engineering Center's (TARDEC's) ongoing hit-avoidance research effort, used a simulated prototype Vehicle Integrated Defense System (VIDS) as its conceptual protection system. VIDS is composed of a system of sensors and countermeasures and a counterfire system regulated by an artificial intelligence module to assist the operator to defend the vehicle. Platoon combat survivability and lethality while using the M1 tank with and without VIDS was examined. Research objectives were to (a) determine if VIDS enhanced platoon combat operational effectiveness, (b) determine the optimal VIDS configuration, (c) identify future training requirements and soldier-machine interface issues, and (d) identify impacts on tactics, techniques, and procedures. Four platoons operated baseline M1s and four progressively arrayed VIDS-configured tanks in repeated realistic combat engagements in bi-weekly evaluation sessions. Findings indicated VIDS-equipped platoons survived significantly better and progressive additions of sensors and countermeasures enhanced platoon survivability. The effect of VIDS on lethality performance was negligible, except

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13. ABSTRACT (Continued)

platoons were more lethal before receiving their first hit or kill. The VIDS configuration with the most sensors and countermeasures was the optimal choice. Future training requirements and modifications and enhancements to the VIDS system were identified for improving performance.

Research Report 1671

A Simulation-Based Evaluation of a Force Protection System: Soldier Performance, Training Requirements, and Soldier-Machine Interface Considerations

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Training Simulation

FOREWORD

The Future Battlefield Conditions team of the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) Armored Forces Research Unit is responsible for conducting research to enhance soldier preparedness to meet the demands of future battlefields. The team does this by conducting soldier-in-the-loop simulations at the Mounted Warfare Test Bed (MWTB) at Fort Knox, Kentucky.

The possibility exists that our land combat forces may have to rapidly deploy to various countries and third-world nations and face hostile forces that possess advanced and sophisticated anti-armor smart weaponry. The U.S. Army has been investigating hit-avoidance technologies, which can provide increased protection to combat vehicles without adding heavier armor protection. This research was designed to experimentally evaluate a force protection system in simulation. It was sponsored by the Tank Automotive Research, Development, and Engineering Center (TARDEC), Program Manager (PM) Survivability, and PM Combat Identification, and was conducted with the U.S. Armor Center's Mounted Warfighting Battlespace Laboratory (MWBL) and Directorate of Combat Developments (DCD).

The evaluation assessed the combat operational effectiveness of M1 armor platoons equipped with four progressive versions of a Vehicle Integrated Defense System (VIDS). VIDS is composed of a system of advanced sensors and countermeasures and a counterfire system regulated by an artificial intelligence module and a visual display of battlefield information to assist the vehicle commander in defending the vehicle. The results indicated that (a) VIDS significantly enhanced platoon survivability and provided some improvements in lethality, and (b) the most progressively arrayed VIDS system was the best choice for optimum operational effectiveness. In addition to these results, future training requirements, VIDS design improvements, and improvements to combat power were identified. This research provides an example of how soldier-in-the-loop simulation can be used to evaluate technological enhancements to current and future battlefield operations.

This force protection evaluation has been briefed to the following personnel: Commanding General, U.S. Army Armor Center and School; Assistant Commandant, U.S. Army Armor School; Director, Survivability Technology Center, Tank Automotive Research, Development, and Engineering Center; Assistant PM for Electronic Warfare, PM Survivability Systems; Director, MWBL; and Director, DCD.

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The authors appreciate the guidance and assistance provided by the force protection evaluation steering committee in the developmental stages of this research effort. Steering committee members included Kathleen Quinkert (U.S. Army Research Institute, Armored Forces Research Unit), Lieutenant Colonel Joseph Orr (Mounted Warfighting Battlespace Laboratory), and Lieutenant Colonel John Bartley (Directorate of Combat Developments, Armor Center). Captain Jeffrey Iddins was an invaluable member of the evaluation team, serving as part of the training staff, a subject matter expert, and as the Company Commander for scenario execution. Special appreciation is extended to David Bessemer (U.S. Army Research Institute, Armored Forces Research Unit) for his advice on experimental design and statistical analysis.

The LORAL Advanced Distributed Simulation (LADS) evaluation team members who assisted in the development and execution of this evaluation were Ryszard Lozicki, Owen Pitney, and Timothy Voss. Automated data collection and reduction support was provided by two LADS analysts, Paul Monday and Robert Yagelowich. LORAL Training and Technical Services (LTTS) provided support in training and data collection, site management, and technical support of simulation equipment. Research assistants supporting the training and data collection were Daniel Schultz, Kenneth Fergus, David Johnson, and Charles West. Thomas Radgowski provided site management services. Robin Smith, Ronald Fackler, and David Clippinger provided simulation equipment support.

A SIMULATION-BASED EVALUATION OF A FORCE PROTECTION SYSTEM: SOLDIER PERFORMANCE, TRAINING REQUIREMENTS, AND SOLDIER-MACHINE INTERFACE CONSIDERATIONS

EXECUTIVE SUMMARY

Requirement:

A pressing concern for military planners is the proliferation of advanced and sophisticated anti-armor smart weaponry in various countries and third-world nations in which our land combat forces may be required to rapidly deploy and operate. To address this concern, the U.S. Army has been investigating hit-avoidance technologies, which can provide increased protection to combat vehicles without adding heavier armor protection. The Tank Automotive Research, Development, and Engineering Center (TARDEC) sponsored a live demonstration of hit-avoidance technologies applied to a light armored vehicle to display the potential of a Vehicle Integrated Defense System (VIDS) to increase vehicle survivability. Given the prohibitive costs of conducting field evaluations of various protective suites, a feasibility study was conducted by the U.S. Army Armor Center's Directorate of Combat Developments to demonstrate the capability to evaluate hit-avoidance technology using soldier-in-the-loop simulation. The outcome of the feasibility study demonstrated the need to experimentally evaluate hit-avoidance technology in simulation. The focus of this evaluation was to (a) experimentally determine the relative operational effectiveness of various hit-avoidance technologies by comparing the performance of M1 platoons with and without various VIDS suites, (b) determine an optimal VIDS suite, (c) identify future training requirements and soldier-machine interface considerations, and (d) assess the impact of VIDS on tank platoon tactics, techniques, and procedures.

Procedures:

The evaluation compared tank platoon performance under five configurations: a baseline configuration using the conventional capabilities of the M1 tank and four progressively arrayed VIDS configurations of sensors, countermeasures, plus a counterfire system. During eight bi-weekly evaluation sessions, four crews (tank commanders (TCs), gunners, and drivers) were assembled as tank platoons to operate autoloading M1 tank simulators in the Mounted Warfare Test Bed at Fort Knox, Kentucky. Each platoon operated the tank simulators in all five configurations twice: baseline configuration twice and the four VIDS configurations in semi-automatic and automatic mode. Four tank platoons each completed 2-1/2 days of training, after which they completed 30 realistic combat scenarios in 7 days. Three combat scenarios composed of ten identical threat engagements were repeated in blocks of three for each of the resulting ten configuration treatments. Each of the four platoons received a differing sequence of configuration, operating mode, and scenario presentation to counter learning effects.

Findings:

The results of the evaluation revealed that the addition of VIDS improved platoon operational effectiveness in terms of survivability but did not improve platoon lethality in all instances. Compared to when operating in the baseline configuration, VIDS-equipped platoons (a) were engaged, hit, and killed significantly less often by enemy tank main gun fire, (b) significantly reduced the enemy's standoff range, and (c) sustained significantly fewer engagements and hits from short-range and long-range ground-launched

and air-launched guided missiles. In addition, increasing the number of sensors and countermeasures for each subsequent VIDS configuration increased the survivability of the platoon. There was a noted tendency for VIDS-equipped platoons to commit more fratricide. In terms of battlefield lethality, VIDS offered no significant enhancement for detection (as measured), although some improvements were observed for contacting the enemy at longer ranges and destroying them slightly quicker. However, VIDS-equipped platoons, as compared to when not using VIDS, survived significantly longer on the battlefield once engagements started and destroyed more enemy vehicles and aircraft before sustaining their first platoon element hit or kill.

Training issue results indicated the participants were generally favorable about the training they received, with recommendations to increase VIDS hands-on training, VIDS and crew integration training, and tactical training with VIDS for any future evaluations. TCs identified the amount of programmed instruction time and type of training for new equipment on VIDS-related tasks. Primarily, they perceived that most of the instruction time should be spent on the simulator on identifying and locating threats, determining their priority, and countering their munitions and platforms. Second, they perceived simulator and tank time should be spent on integrating VIDS operations into crew operations. They also indicated relatively less simulator and real tank training time would be required for training the incorporation of VIDS information into battlefield reporting and integrating VIDS into platoon tactical maneuver. A number of suggestions for improving the training program were made in six areas: classroom, hands-on simulator training, demonstrations, roundtable discussions, tactical exercises, and simulation/simulator improvements.

As for soldier-machine interface considerations, the TCs rated the VIDS system as acceptable with some exceptions. Functions and features rated unacceptable were touch screen input functions, threat priority assignment function and display features, threat icon deletion functions, end-of-engagement procedures, and automated main gun counterfire function. Results of the workload analysis for TC tasks indicated higher workload associated with the acquisition of gunnery targets and evasion of anti-tank missiles compared to preparing and sending CONTACT and SPOT reports. Also, a tendency was noted for higher workload associated with VIDS configurations with more sensors and countermeasures. Frustration from loss of turret control (from automated counterfire) appeared to account for the higher workload. Frequency of visual equipment usage was impacted by the introduction of the VIDS visual display into the TC's work area; TCs sacrificed relatively more gunnery sight time to use the VIDS display. In addition, there was a noted tendency for platoon sergeants to use the visual display more so than the platoon leaders, possibly because of their prior platoon tactical experience or role in platoon operations. Additionally, there were soldier recommendations directed at improving the VIDS design in six areas: VIDS display, display keys, audible tone alerts, voice message alerts, countermeasures, and counterfire.

Assessment of VIDS impacts on specific tank platoon tactics, techniques, and procedures could not be made because of the experimental constraints and lack of direct observational tools for subject matter experts. However, noted enhancements were observed for improving the dynamics of combat power: maneuver, firepower, protection, and leadership.

Utilization of Findings:

The results and lessons learned from this evaluation provide input into the evaluation of future hit-avoidance research efforts and force protection systems being developed for land combat forces. Findings from this research effort will be used by TARDEC in support of their hit-avoidance research program. The Mounted Warfighting Battlespace Laboratory (MWBL) plans to use the findings and lessons learned in designing and developing a conceptual digitally linked force protection system. In addition, the repeated measures, within-subjects experimental design used in this evaluation will be adapted as the model for the MWBL's planned follow-on evaluation.

A SIMULATION-BASED EVALUATION OF A FORCE PROTECTION SYSTEM: SOLDIER PERFORMANCE, TRAINING REQUIREMENTS, AND SOLDIER-MACHINE INTERFACE CONSIDERATIONS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

A SIMULATION-BASED EVALUATION OF A FORCE PROTECTION SYSTEM: SOLDIER PERFORMANCE, TRAINING REQUIREMENTS, AND SOLDIER-MACHINE INTERFACE CONSIDERATIONS

INTRODUCTION

The research effort described in this report is part of a larger effort to develop an integrated suite of survivability systems for the combined arms force. The experimental evaluation of the Vehicle Integrated Defense System (VIDS) was conducted in the Mounted Warfare Test Bed (MWTB) at Fort Knox, Kentucky, from February through April 1994. Issues relevant to combat operational effectiveness, training, soldier-machine interface (SMI), and tactics, techniques, and procedures (TTPs) were examined.

The VIDS evaluation was a joint effort between the Armor Center's Mounted Warfighting Battlespace Laboratory (MWBL), Directorate of Combat Developments (DCD), and the Army Research Institute (ARI) Armored Forces Research Unit. In addition to these agencies, the Army Materiel Command (AMC) provided technical and managerial assistance through the Simulation, Training, and Instrumentation Command (STRICOM), Tank Automotive Research, Development, and Engineering Center (TARDEC), and Program Manager for Survivability (PM-Survivability).

BACKGROUND AND REVIEW OF KEY LITERATURE

Background

The Department of Defense Science and Technology (S&T) Strategy developed by the Director of Defense Research and Engineering (DDR&E) provides a new approach to the research, development, and acquisition process. It was developed in 1993 to respond to changes in the strategic environment faced by the United States. This strategy was shaped primarily because of the effects of a relaxation in East-West tensions and from lessons learned from Operations Urgent Fury, Just Cause, Desert Shield, and Desert Storm. Its objective is to maintain the technological advantage of our forces through an acquisition process with three primary elements: (a) sustaining and applying the dramatic advances in technology, (b) involving the user early and often, and (c) demonstrating the technology extensively and realistically.

The S&T strategy emphasizes seven major technology thrusts. These thrusts are explained in the Army Science and Technology Master Plan (U.S. Department of the Army, 1993a). Of significance to this research is the fifth thrust, Advanced Land Combat (ALC). The ALC thrust is to develop and demonstrate technologies in computers, software, signal processing, sensors, communications, networking, electronic devices, advanced materials, artificial intelligence, and simulation that enhance warfighting capabilities of a lighter "heavy" force. This development is accomplished through the use of four top-level demonstrations (TLDs) with associated Advanced Technology Demonstrations (ATDs). These four TLDs include Advanced Vehicle Technologies, Rapid Force Projection Initiative, the 21st Century Land Warrior, and Countermine.

The Advanced Vehicle Technologies TLD emphasizes improvements in medium to heavy ground force vehicles. The goal of this TLD is to provide superior combat capabilities with reduced vehicle size and weight to enhance deployability and sustainability. Payoffs include greater flexibility in the use of ground forces and greater tactical mobility and agility. One of the associated ATDs in this TLD is hit avoidance. The Hit Avoidance ATD focuses on innovative survivability technologies featuring integrated suites of threat sensors and countermeasures to provide lighter weight protection of armored vehicles.

At present, the most pressing concern of military planners working within the ALC Thrust is the proliferation of late model armored vehicles and sophisticated anti-tank weapons to regional powers from the world arms export market. The primary sources of this equipment are the former Soviet Republics and

WARSAW Pact members. These nations, confronted by reduced defense budgets and declining economies, have sold inventories of advanced weaponry at a fraction of its cost to various countries and third world nations. The possibility exists that our land combat forces will have to rapidly deploy and operate in extremely lethal and remote environments. Thus, it is imperative to develop highly capable and survivable land combat systems which can rapidly deploy to a region, exercise a high degree of tactical mobility, and overwhelm the enemy quickly and with minimum casualties in the presence of a heavy armor threat and smart weaponry. It is in the context of this threat that this evaluation examined the effect of hit avoidance technologies on survivability and lethality of land combat vehicles.

Given the conceptual nature of this rapidly maturing technology plus the prohibitive expenses in developing, constructing, and evaluating prototypical systems in field environments, a key approach is to perform evaluations using virtual prototypes in a simulation environment. Of the many types of simulations available, the Battlefield Distributed Simulation-Developmental (BDS-D) environment was chosen for this Hit Avoidance ATD. There are two advantages to conducting evaluations in the BDS-D environment. One is the opportunity for warfighter involvement. With soldiers in simulators and subject matter experts (SMEs) observing, researchers are able to better assess crew needs in an operational environment. This is an essential element within the S&T strategy. Second, the BDS-D environment creates an opportunity for soldiers, scientists, and developers to combine efforts, under one roof, to address problems as they occur and recommend improvements for later designs.

VIDS constitutes a hit avoidance technology that uses a microprocessor-based system designed to integrate subsystems on board a host vehicle to defeat enemy weapons systems. Such subsystems include sensors, countermeasures (CMs), turret drive, communications, and controls. The microprocessor uses a Threat Resolution Model (TRM) to serve as the artificial intelligence which alerts the crew and initiates automatic CMs or recommends vehicle commander actions based upon sensor inputs. Hit avoidance was one of four avoidance technology categories which described survivability design measures within the original Armored Systems Modernization (ASM) Program. Detection, penetration, and kill avoidance technologies were the other three categories.

The purpose of the ASM program was to develop the next fleet of armor vehicles (Ludvigsen, 1991). This fleet was intended to replace current armor systems whose design potential would be exhausted by the turn of the century. Developers within the ASM program are interested in the expected benefits to be gained for fighting vehicles from an effective hit avoidance system. Among these advantages are improved situational awareness, reduced space and weight burdens, enhanced maneuverability, and most important, increased survivability.

Eglin Demonstration

As part of the overall ASM effort, TARDEC sponsored a live VIDS demonstration at Eglin Air Force Base in August 1992 (Fowler & Simpson, 1993). This was the first test of a VIDS-equipped vehicle. The primary objective of this demonstration was to document the effectiveness of the design and construction of a VIDS system built for a Bradley Fighting Vehicle (BFV). Other objectives of the demonstration were as follows (Fowler & Simpson, 1993, p. 5):

1. Provide opportunity for user input into VIDS development.

2. Evaluate electronic warfare (EW) effectiveness as vehicle protection.

3. Quantify sensor performance.

4. Develop tactics, techniques, and procedures (TTP) for training soldiers on VIDS.

5. Identify VIDS deficiencies.

6. Evaluate embedded training capabilities.

7. Demonstrate integration techniques on a test vehicle.

The VIDS system developed for the BFV included basic VIDS architecture and a subsystem mix of sensors and CMs. The basic VIDS architecture included a microprocessor, gunner sight camera, operator control console, power conditioner unit, and a vehicle interface box. The microprocessor used a TRM to generate key system and vehicle commander responses. Sensors used were the Automatic Chemical Agent Detector Alarm, Radar Warning Receiver, Laser Warning Receiver, and Non-Imaging Sensor. One CM, the Multi-Salvo Grenade Launcher and Counterfire were also used.

During the demonstration, system performance and effectiveness varied greatly according to the particular subsystem. The Laser Warning Receiver was able to provide 360 degree coverage at an accuracy of less than two degrees and discriminate between laser ranger finder (LRF) and laser designator emitters. The Radar Warning Receiver was effective in so far as it provided an early warning capability which had been unavailable previously. However, the immaturity of the Radar Warning Receiver resulted in the system experiencing considerable reflection problems. The Non-Imaging Sensor constantly malfunctioned and produced inconclusive results as to its effectiveness. The Multi-Salvo Grenade Launcher demonstrated an advantage over the existing smoke grenade launcher through its automated management of ammunition inventory, placement, and fires.

The results of the demonstration suggested that VIDS could increase the survivability of future armored fighting vehicles and that development should continue. The demonstration also recommended that future system designs allow integration into existing ground vehicle fleets. The field demonstration was limited by the existence of only one VIDS-equipped vehicle. In order to investigate small unit implementation of VIDS, look further at soldier-in-the loop issues, and examine a wider suite of sensors and countermeasures, a decision was made to transition experimentation into a distributed interactive simulation (DIS) environment.

The Mounted Warfare Test Bed (MWTB)

The MWTB at Fort Knox, Kentucky, originally known as Simulation Networking-Developmental (SIMNET-D) then later as the Close Combat Test Bed (CCTB), is a DIS facility containing low cost, distributed network simulators that are used to simulate battalion and below combat operations in a virtual battlefield environment. This simulation, primarily used for conducting research associated with maneuver and command and control operations, allows manned and semi-automated weapon platforms to interact on digitized representation of real-world terrain. The MWTB's resources allow researchers and combat, training, and material developers to experiment, test, and evaluate conceptual weapon systems, tactics, training, and doctrine (Garvey, Radgowski, and Heiden, 1988).

While it is important to understand the capabilities, advantages, and limitations of the MWTB, it is not necessary to recount all the detailed information in this report. Previous documentation (Miller and Chung, 1987; BBN Systems and Technologies Corp., 1991) and ARI reports (Du Bois and Smith, 1989; O'Brien, Wigginton, Morey, Leibrecht, Ainslie, and Sawyer, 1992) thoroughly describe the MWTB research resources, capabilities, and constraints. Thus, in subsequent sections, only the capabilities, advantages, and limitations relevant to this evaluation are summarily described.

MWTB Capabilities

The central components of the MWTB are the M1 Abrams simulators which utilize the principal of selective fidelity in their design. That is, the M1 simulator models the behavior of the real tank as much as possible and contains the minimum level of detail necessary for the armor crewman to perceive the system as realistic and useful. Visual and sound components are provided to simulate battlefield-oriented perceptual cues to reproduce key aspects of the battlefield operating environment. In addition to the M1 simulator, a variety of computer-based systems are used to provide tactical communications, scenario monitoring and

control, and data collection and analysis capabilities (Leibrecht, Winsch, Ford, Sawyer, Meade, Ainslie, Smith, Sever, and Doherty, 1993).

Leibrecht, et al (1993) detailed a comprehensive list of MWTB features. Only features relevant to this evaluation are adapted to provide the following brief descriptive listing. The relevant MWTB major features include:

1. Manned simulators which contain selective fidelity crewstations with supporting hardware and software (including digitized terrain database).

2. Voice (and digital) tactical communications on a simulated single channel ground-to-air radio system (SINCGARS) network for linking manned simulators and control stations.

3. Surrogate vehicles added to the battlefield via a semi-automated forces (SAFOR) program which creates and controls unmanned friendly and enemy vehicles and aircraft.

4. Scenario control accomplished through a Management, Command, and Control (MCC) system which provides a capability to initialize and monitor manned simulators and implement fire support.

5. Scenario monitoring accomplished via (a) a Plan View Display (PVD) which provides a "bird's eye view" of the simulated battlefield and supports map manipulation and event flagging and (b) a stealth station (including a large screen monitor) for viewing the battlefield from various viewpoints.

6. Data recording and analysis accomplished via a Data Collection and Analysis (DCA) system which allows recording (and playing back) automated data and performing off-line reduction. It consists of a DataLogger for capturing all network data and two types of analysis software: DataProbe and RS/1 (registered trademarks of BBN Software Products Corporation).

7. Simulation network control accomplished with a network control station which has the capability to save and restart exercise states.

MWTB Advantages and Disadvantages

Advantages

The MWTB offers many unique advantages over other simulations and the field environment. O'Brien et al (1992) cited several which include: (a) flexibility in allowing crews to perform a broad range of missions, (b) versatility in providing realistic engagement interaction in a variety of simulated battlefield settings, (c) capability to present tank crews and units with operationally realistic task and mission loading levels, (d) fidelity of tactical communications, (e) adaptability in ensuring standardization of experimental procedures, (e) value in identifying training requirements, (f) relatively low cost in evaluating experimental configurations of systems, (g) automated capability to capture and analyze objective performance data, and (h) unique analysis capabilities afforded by playback.

Limitations

Despite the many advantages offered by the large-scale simulation in the MWTB, there are limitations. Leibrecht et al (1993) summarized and updated limitations originally addressed by Du Bois and Smith (1989). Those limitations, adapted for use here, include the following: (a) limited visual fidelity of the computer-generated imagery, which limits depth perception, battlefield orientation, long-range target identification, and certain tactical maneuvers, (b) maximum simulated viewing distance of 3500 m, resulting in a potentially misrepresented horizon, (c) loss of vision block imagery when the computer image generator (CIG) is overloaded, (d) inability to conduct open hatch operations, which, together with a limited number of cupola vision blocks (including no vertical tilting of vision blocks), constrains the vehicle commander's view of

the battlefield and complicates navigation, (e) limited fidelity of the dynamic battlefield environment, including a zero-motion platform, limited representation of combat noises, absence of weather variations and atmospheric degradations, and lack of dynamic terrain, (f) absence of machine guns, (g) problematic performance of the sighting and fire control systems, such as difficulty in maintaining proper bore sight and unrealistic implementation of target lead functionality, (h) simplistic implementation of combat support (e.g., fire support) and combat service support (e.g., resupply), (i) unrealistic behavior of semi-automated forces (SAFOR) vehicles, including perfect identification of targets, unrealistic fire control and distribution, and failure to use cover and concealment when moving, (j) inability to readily identify friendly tank bumper numbers beyond 200 meters, resulting in problematic identification of unit members (especially during maneuvers), and (k) lack of a gunner's auxiliary sight (GAS), constraining the use of terrain for protective positioning, and (l) lack of a thermal imagery sight (TIS) for seeing through smoke obscuration.

Several special features have been adapted to offset some of the listed limitations. Inside the simulator, a grid azimuth indicator and turret-to-hull reference display have been added to offset the closed hatch operations and assist in positioning, maneuvering, and navigating. Special SIMNET topographic paper maps (with representations of buildings, rivers, roads, etc.) are provided to offset the limited visual fidelity. Special tactical guidelines and training in navigation and simulation peculiarities have been developed to compensate for the limited visual distance and fidelity.

Notwithstanding these limitations, the MWTB simulation environment offered the best simulation opportunity to evaluate the VIDS capabilities.

BDS-D Test (Phase I)

The Directorate of Combat Developments (DCD) conducted the first BDS-D evaluation of the VIDS concept from April through June 1993 at the MWTB under the sponsorship of the Advanced Research Projects Agency (ARPA), PM-Survivability, and TARDEC. The driving force behind the evaluation was the Program Executive Office for Armor System Modernization (PEO-ASM). The MWTB was suggested as an ideal environment for building on the lessons learned from Eglin and deriving warrior-in-the-loop insights without the expenses normally associated with hardware demonstrations.

The objectives of this evaluation were to: (a) demonstrate the feasibility of using simulation to portray a vehicle self-protection system, (b) assess the operational benefits of VIDS sensor and countermeasure configurations, (c) identify operational performance requirements for future VIDS architecture, systems, and subsystems, (d) identify key soldier-machine interface (SMI) issues and implications which could influence future VIDS suite configurations and design, and (e) assess the potential impact of VIDS operation on combat platoon TTPs (BDM Federal, Inc., 1993).

In the evaluation, qualified tank crews filled the roles of platoon leader (Plt Ldr), platoon sergeant (Plt Sgt), gunners, and drivers using two M1 tank simulators. Wingmen tanks were tethered to the manned leader tanks through the use of SAFOR. To facilitate research data collection, the loader positions were manned by research assistants and the tank simulators were modified with an autoloader. The tank simulators were equipped with a touchscreen that represented the design and functions of the Commander's Control and Display Panel (CCDP). Four different platoons were formed from a pool of soldiers at Fort Knox. Each platoon completed four scenarios. Each scenario was composed of a hasty defense, hasty attack, meeting engagement, and ambush engagement. Each platoon completed a five day training and testing cycle.

Seven tested conditions included a baseline M1 tank simulator (a control condition) and six differently configured VIDS-equipped M1 tank simulators (experimental conditions). The basic capabilities of the M1 tank simulator in the MWTB have been well documented (Du Bois & Smith, 1989) and, thus, are not repeated here. The additional capabilities of the VIDS-equipped M1 tank simulators used in Phase I are illustrated in Table 1. As shown, there were five sensors and CMs utilized in this evaluation. These were the high accuracy Laser Warning Receiver (LWR), Missile Countermeasure Device (MCD), Missile Warning

Table 1

Summary of Battlefield Distributed Simulation-Developmental (BDS-D) Phase I Vehicle Integrated Defense System (VIDS) Experimental Configurations

Configuration	Description
MCD	In this configuration, no sensors were available. VIDS did not detect any threats, but the crew could manually respond to any visually detected anti-tank guided missiles (ATGMs) using the MCD.
LWR	In this configuration, VIDS detected and responded to laser emissions. Only laser threats directed at the VIDS equipped vehicle were detected. Audible alert tones were sounded and threat icons displayed on the Commander's Controls and Display Panel (CCDP) when VIDS detected an enemy Laser Range Finder (LRF), Laser Beam Rider (LBR), or Laser Designator (LDES) emission. VIDS could respond to any detected threat using semi-automatic or automatic counterfire (to align the main gun with the threat).
MCD, MWS	In this configuration, VIDS detected missile launch signatures. Audible alert tones were sounded and threat icons appeared on the CCDP when the VIDS equipped vehicle was in a path of a detected missile launch. All detected missiles were displayed as hostile ATGMs. VIDS could respond to any detected threat using the MCD (to jam the incoming missile) or counterfire (to align the main gun with the threat) in manual, semi-automatic, or automatic mode. Although LBR and LDES launches were detected, they were not affected by the MCD.
LWR, MSGL	In this configuration, VIDS detected laser emissions directed at the VIDS equipped vehicle. Audible alert tones sounded and threat icons appeared on the CCDP when VIDS detected an enemy LRF, LBR, or LDES. VIDS could respond to any detected threat using smoke grenades (to disrupt the incoming missile or provide cover) or counterfire (to align the main gun with the threat) in manual, semi-automatic, or automatic mode.
MWS, MSGL	In this configuration, VIDS detected missile launch signatures. Audible alert tones sounded and threat icons appeared on the CCDP when the VIDS equipped vehicle was in the path of a detected missile. All detected missiles were displayed as hostile ATGMs. VIDS could respond to any detected threat using smoke grenades (to disrupt infra-red (IR)-guided missiles or provide cover), or counterfire (to align the main gun with the threat) in manual, semi-automatic, or automatic mode.
LWR, MWS, MCD, MSGL	In this configuration, VIDS detected laser emissions and missile launch signatures. Audible alert tones sounded and threat icons appeared on the CCDP when VIDS detected a laser emission (enemy LRF, LBR, or LDES), or was in the path of a detected missile. VIDS could respond to any detected threat using the MCD (to jam incoming ATGMs), smoke grenades (to disrupt IR-guided missiles or provide cover), or counterfire (to align the main gun with the threat) in manual, semi-automatic, or automatic mode.

Note. MCD = Missile Countermeasure Device; LWR = Laser Warning Receiver; MWS = Missile Warning System; MSGL = Multi-Salvo Grenade Launcher.

System (MWS), Multi-Salvo Grenade Launcher (MSGL), and automatic/semi-automatic counterfire (CF) with main gun. Table 1 also summarizes the six VIDS experimental configurations and their target

acquisition and engagement operations (BDM Federal, Inc., 1993). The VIDS CMs were operational in any one of three modes. The tank commander (TC) either activated a CM by pressing a button on the CCDP (manual mode), used the Commander's Control Handle (CCH) to deploy a CM recommended by the system (semi-automatic mode), or allowed the system to recommend and automatically deploy a CM (automatic mode).

Results from the Phase I evaluation suggested a viable role for hit avoidance technologies, such as VIDS, on the future battlefield. Crews using VIDS detected nearly all threat attacks at longer ranges than the M1 condition, and were generally satisfied with initial protection provided by VIDS. There was concern expressed pertaining to: TC and gunner coordination, the crew's loss of control over the turret in semi-automatic and automatic modes, and TC and gunners' lack of ability to engage threat vehicles while MCD and MSGL were in operation. Vehicle commanders were mostly satisfied with all aspects of the VIDS system audible alerts and information display. Some confusion was expressed about the relationship of the hull and turret with regard to the threat icons displayed on the CCDP. In addition, soldiers using the equipment provided numerous comments and recommendations that were used to improve the VIDs simulation software and system designs.

In summary, the first evaluation provided a demonstration of the VIDS capabilities using soldier-in-the-loop simulation. Although the evaluation was not designed to provide statistically valid results to demonstrate enhanced effectiveness, it did document insights into the potential of a VIDS system and, more importantly, identified warrior input for design changes and TTP requirements for future systems (BDM Federal, Inc., 1993). These insights also included changes to the existing simulation capabilities in the MWTB.

As a result of these findings and the need to continue VIDS concept exploration within soldier-in-the-loop simulation, the Army community gave the mission to MWBL. One of MWBL's major roles is to exploit the DIS environment to assess the potential of virtual prototypes before proceeding to live simulation and possible acquisition. DCD and ARI's Fort Knox research unit were teamed with MWBL to provide needed subject matter expertise and scientific oversight, respectively.

The driving force behind the decision to conduct continued evaluation was the need to determine the differences in effectiveness attributed to the VIDS addition to the M1 and under what circumstances does it offer the most payoff. There was also a desire on the part of the Army community to determine the optimal VIDS configuration, i.e.,suite of sensors and CMs that would provide enhancements to combat operational effectiveness. Lastly, there was a desire to further explore the training requirements, SMI issues, and TTPs associated with the operational use of the system. These research issues and goals were incorporated by the joint evaluation team into an experimental evaluation.

Evaluation Issues

The previous BDS-D evaluation was designed to demonstrate the potential of portraying VIDS in the BDS-D environment and identify, assess, and explore the potential impact of VIDS. Although the evaluation illustrated the feasibility of conducting a BDS-D evaluation of VIDS, it did not conclusively demonstrate the potential impact of VIDS on combat operational performance. Also, new sensors and CMs were created since the first BDS-D experiment. The objectives of this experimental evaluation were to significantly demonstrate the potential increased operational effectiveness of VIDS, identify an optimal suite of sensors and CMs, and examine and identify training issues, SMI issues, and TTP impacts associated with VIDS. The objectives can be summarized in four research questions:

(1) What is the relative combat operational effectiveness of the M1 VIDS configured vehicles in comparison to the M1 baseline system?

(2) Of the VIDS configurations, which is the best configuration for optimal combat operational effectiveness?

(3) What are the relevant training and SMI issues and requirements for the future VIDS system?

(4) What is the impact of soldiers using VIDS configured vehicles on combat platoon TTPs?

The first two issues were operational effectiveness issues. Operational effectiveness, for this evaluation, referred to VIDS impact on vehicle survivability and lethality. Hit avoidance measures constituted the primary focus for operational performance for survivability. Detection, acquisition, and engagement outcomes constituted the primary measures for lethality operational performance. It was generally hypothesized that (a) each configuration of VIDS-equipped M1s would be more survivable and lethal compared to the baseline M1 configuration and (b) progressive arrays or suites of VIDS sensors and CMs would incrementally increase the survivability and lethality of each VIDS suite.

The third issue focused on examining the training and SMI issues, implications, and requirements. Objective and subjective information was the primary data for examining training program effectiveness. Subjective information was the primary data used for identifying training implications, future training requirements, SMI and workload implications, and future design requirements. No hypotheses were proposed since this issue was exploratory in nature.

The fourth issue focused on identifying TTPs associated with VIDS and impacts VIDS might have on current small unit operations. Subjective information from soldiers and observers served as the primary source for exploring this issue. No hypotheses were proposed for this issue.

In order to accomplish the research objectives (articulated as issues), software modifications to both the VIDS system and the BDS-D were required.

BDS-D Software Development

As stated previously, several modifications and new design capabilities were identified as requirements for the systems software and simulation capabilities to continue experimental evaluation. These changes provided an expanded set of sensors and countermeasures. Additionally, the SAFOR simulation software was updated to provide a wider array of threat weapons systems.

In addition to the sensors and CMs employed in the first BDS-D evaluation (see Table 1), several new sensors and CMs were developed for the VIDS system. These included: (a) Non-Imaging System (NIS), (b) Muzzle Flash Detector (MFD), (c) Tank Radar Warning Receiver (TRWR), (d) Future Armored System Radar (FASR), (e) Pedestal Operated Multi-Ammunition Launching System (POMALS), (f) Combat Protection System (CPS), (g) Laser Countermeasure Device (LCMD), and (h) Threat Countermeasure System (TCS). (Acronyms and definitions for this report are listed in Appendix A.) These software developments and modifications were integrated into the SIMNET at the MWTB during functional testing prior to the experimental evaluation. Table 2 provides a summary of the four progressively arranged VIDS configurations and their operations used in this evaluation.

Specific fixes to the VIDS software in simulation included: (a) independent steering of countermeasures from the turret drive (which provides the capability to engage threat targets when countermeasures like the MCD and MSGL are employed), (b) improved smoke visual effects, and (c) faster response times for the CCDP. Additionally, new threat weapons systems were added to SAFOR code in order to further evaluate the sensors and CMs. New ATGM threats included: (a) AT-2C ATGMs (with radio frequency uplink), (b) AT-4 ATGMs (wire-guided missiles), (c) AT-6 ATGMs (similar to AT-2C with different operating parameters), (d) AT-9 ATGMs (equivalent to U.S. Hellfire missile which utilizes a designating laser), and (e) AT-11 ATGMs (similar to AT-9 but with laser beam rider guidance). New threat weapon platforms include: armored reconnaissance scout vehicle (BRDM-2), Mi-24 attack helicopter (HIND), and T-80 tank.

Table 2

Summary of Vehicle Integrated Defense System (VIDS) Experimental Configurations and Operations

Configuration	Description
LWR, MWS, MCD, POMALS, CF	In configuration 1, VIDS detects laser emissions (with LWR) and missile launch signatures (with MWS). Only laser threats directed at the VIDS-equipped vehicle are detected. Audible alert tones are sounded and threat icons are displayed on the CCDP when VIDS detects an enemy laser emission (LRF, LBR, or LDES) or detects a missile launch. VIDS can respond to any detected threat using MCD (to jam incoming missiles), POMALS (smoke grenades to disrupt incoming IR-guided missiles or provide cover), or Counterfire (CF) (to align the main gun with the threat) in semiautomatic or automatic mode.
LWR, MWS, NIS, FASR, POMALS, CF	In configuration 2, VIDS detects everything previously detectable plus detects acoustic signatures of rotary aircraft (with NIS) and bearing/speed/location of ground and air platforms (with FASR). In addition to the same audible alert tones and threat icons, voice messages are delivered when helicopters are detected or identified. Ground and air platform icons are displayed on the CCDP when VIDS radar detects, classifies, and tracks ground or air platforms in its sector range. VIDS responds with the same countermeasures (CMs) and CF as before.
LWR, MWS, NIS, FASR, TRWR, MCD, POMALS, CPS, CF	In configuration 3, VIDS detects everything previously detectable in configuration 2 plus detecting radar emissions (with TRWR). Ground and air platform icons are displayed on the CCDP when threat radar emissions strike the VIDS-equipped vehicle. VIDS responds as before plus it uses CPS (to disrupt optical tracking systems).
LWR, MWS, NIS, FASR, TRWR, MFD, CPS, LCMD, TCS, Flares, CF	In configuration 4, VIDS detects everything detectable in the previous configuration plus detecting muzzle flashes (with MFD). The same audible alert tones and voice messages are sounded and threat icons are displayed on the CCDP. VIDS responds similar as before with some exceptions: no smoke grenades (no POMALS) and no missile jamming (no MCD). However, VIDS responds with LCMD (to divert incoming missiles), TCS (to deflect incoming missiles or projectiles), and Flares (to attract and decoy incoming IR-guided missiles).

Note. LWR = Laser Warning Receiver; MWS = Missile Warning System; MCD = Missile Countermeasure Device; POMALS = Pedestal Operated Multi-Ammunition Launching System; LRF = Laser Range Finder; LBR = Laser Beam Rider; LDES = Laser Designator; NIS= Non-Imaging System; FASR = Future Armored Radar System; TRWR = Tank Radar Warning System; CPS = Combat Protection System; MFD = Muzzle Flash Detector; TCS = Threat Countermeasure System.

METHOD

Subjects and Key Personnel

A total of 48 active duty soldiers assigned to the 194th Separate Armored Brigade and 16th Cavalry Regiment at Fort Knox participated in the data collection phase which lasted eight weeks. Participants were scheduled in groups of 12 each to operate four M1 simulators as an armor platoon. Twelve additional soldiers participated in two weeks of pilot testing prior to the data collection phase. The principal evaluation

group were males ranging in age from 21 to 38. Average active duty tank experience for platoon leadership positions were 1 year and 9.5 months for Plt Ldrs, 14 years and 4.5 months for Plt Sgts, and 13 years and 2.35 months for wingmen TCs. (Appendix B contains selected descriptive statistics for key biographical factors for the soldier-participants.)

In response to MWBL's Troop Support Request, supporting units provided four commissioned officers to serve as Plt Ldrs, 12 non-commissioned officers to serve as Plt Sgts and TCs, and 16 enlisted personnel to serve as gunners and drivers. All participants were required to hold current M1/M1A1 armor qualifications. Participants were not usually from the same platoon but may have served together within the same company. Prior to the start of scheduled events, soldiers were assigned duty positions commiserate with their rank. Intact crews from units were redistributed so all crews were newly formed.

Evaluation Team

The evaluation team included: (a) exercise control center (ECC) personnel responsible for controlling training and evaluation events, and monitoring and collecting data, (b) research assistants serving as both primary trainers of individual crewmembers and crews and then later as in-simulator data collectors and monitors, and (c) data management personnel responsible for managing the quality of automatic and manual data capture, reduction, and analysis.

ECC Personnel

The ECC staff controlled the training and evaluation exercises and events, role-played company level positions, collected observational data, and electronically marked automatic data collection events. The staff consisted of an Evaluation Director, Battle Master, and Company Commander (Co Cdr), Team Leader, Stealth Operator/Assistant Battle Master, and a SAFOR Operator. The Evaluation Director was the on-site research scientist responsible for the overall quality of the training and evaluation efforts. The Battle Master and Co Cdr were active duty armor officers (experienced in company command) responsible for the execution of the training and evaluation activities. Both were able to serve in either position to maintain scheduled operations during either's absence. All ECC execution control personnel (Team Leader, Assistant Battle Master, and SAFOR Operator) were experienced in operating the ECC equipment and had extensive background experience in previous simulation evaluations. All could substitute for one another during absences to allow ECC operations to continue.

Research Assistants (RAs)

Under the supervision of the Evaluation Director, four contracted RAs functioned as trainers and in-simulator data collectors and monitors. All had previous experience as RAs; three had served in the previous VIDS BDS-D test. As primary trainers, they conducted hands-on training of the soldier-participants, including (a) explaining and demonstrating simulator and VIDS equipment functions, (b) guiding and supervising in-simulator practice exercises, and (c) evaluating the mastery of VIDS operations (during a skills evaluation). During evaluation trials they collected observational data and monitored the status of the simulator and VIDS equipment. RAs also were required to summon help when equipment malfunctions or failures occurred.

Data Management Personnel

Data management personnel were responsible for the quality of the automated and manual subjective data generated in the training and evaluation. The data quality manager coordinated with MWTB contractor data analysis support staff to ensure data measures were appropriately defined, extracted, and reduced to data files amenable for later analysis. The data quality manager was also responsible for reviewing data for anomalies and establishing parameter rules for correcting anomalous or erroneous data before analysis. The research analyst was responsible for the quality and input of all manually collected data. In addition, the research analyst served as the primary statistical analyst of both automated and manual data.

Evaluation Facilities and VIDS Description

This section describes the MWTB equipment and capabilities used by the participants and the control staff to control and execute training and testing. It includes brief descriptions of the MWTB facility, simulator features, VIDS description, control center equipment, and data collection and analysis system used in the evaluation.

Figure 1 depicts the floor plan layout of the MWTB facility in which the experimental evaluation was conducted.

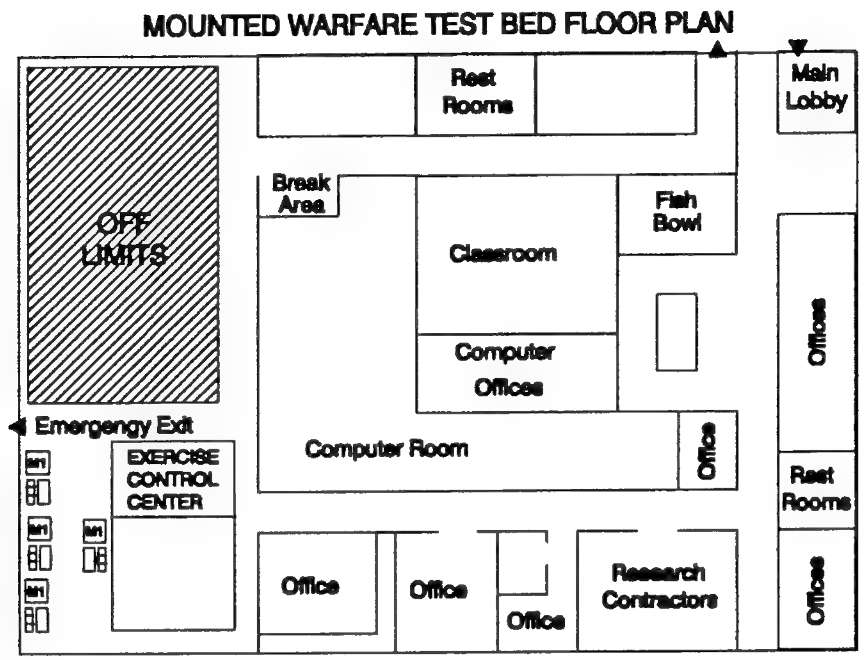

Figure 1. Schematic floor plan of the Mounted Warfare Test Bed (MWTB) facilities.

Simulator Facilities

Four M1 tank simulators were used to support this evaluation. The M1 simulator was the baseline simulator to which VIDS equipment was added to create the experimentally configured tanks. Key features common across the baseline and VIDS configurations included: (a) vision blocks (VBs) at the TC's and driver's crewstations, (b) a grid azimuth indicator, (c) odometer, (d) LRF, (e) gunner's primary sight (GPS), (f) GPS extension (GPSE) at the TC's station, (g) turret-to-hull reference display, (h) simulated SINGARS radio, and (i) automatic loader. The VIDS-equipped simulators included the CCDP and a modified CCH. Table 3 lists the baseline and four VIDS configurations in terms of their system's threat sensor and countermeasure response capabilities in this evaluation.

Crew station layout was the same for baseline and VIDS configurations except for the TC's crew station. In the baseline condition, the CCDP was inoperable and covered. Figure 2 depicts the VIDS TC's crew station. Notice the CCDP is located directly to the front of the TC.

Radio Nets

The M1 simulators were equipped with SINCGARS simulated radios with dual net capability. A platoon net was used for radio traffic between the four tank simulators. A company net, controlled by the Battle Master and/or Co Cdr, was used by the Plt Ldr, Plt Sgt, and ECC personnel.

Table 3

Comparison of System Sensor and Countermeasure Capabilities for Baseline and Vehicle Integrated Defense System (VIDS) Configurations

Sensor/countermeasures	System	Vehicle configurations				
		Baseline	VIDS 1	VIDS 2	VIDS 3	VIDS 4
<u>Threat Detection</u>						
Visual line of sight to 3500 m	VBs/sights	X	X	X	X	X
Battlefield sounds	Soldier	X	X	X	X	X
Incoming threat icon display	VIDS CCDP		X	X	X	X
Audible threat alert tones	VIDS		X	X	X	X
Audible threat voice messages	VIDS			X	X	X
Laser designation detection	LWR		X	X	X	X
Missile launch detection	MWS		X	X	X	X
Aircraft acoustic detection	NIS			X	X	X
Vehicle movement detection	FASR			X	X	X
Radio frequency uplink detection	TRWR			X	X	
Muzzle flash detection	MFD					X
<u>Threat Response</u>						
Direct fire	Main gun	X	X	X	X	X
Main gun slew to target	Counterfire		X	X	X	X
Multi-spectral obscuration	POMALS		X	X	X	
IR missile jamming	MCD		X	X	X	
Optical sight disruption	CPS				X	X
IR sight disruption	Flares					X
Laser false target generation	LCMD					X
Projectile/missile deflection	TCS					X

<u>Note.</u> IR = infra-red; VBs = vision blocks; VIDS = Vehicle Integrated Defense System; CCDP = Commander's Controls and Display Panel; LWR = Laser Warning System; MWS = Missile Warning System; NIS = Non-Imaging System; FASR = Future Armored System Radar; TRWR = Tank Radar Warning Receiver; MFD = Muzzle Flash Detector; POMALS = Pedestal Operated Multi-Ammunition Launching System; MCD = Missile Countermeasure Device; CPS = Combat Protection System; LCMD = Laser Countermeasure Device; TCS = Threat Countermeasure System.

<u>Kill Suppress Feature</u>

To provide for more extensive collection of data, the kill suppress option was used with manned tank simulators. This option prevented the simulator from being mobility, firepower, or catastrophically disabled within the simulated battlefield. Kill suppress was used for the following reasons:

1. Platoon vehicle losses would have affected force ratios between friendly and enemy forces resulting in increased shared hit avoidance burden for surviving vehicles.

2. Maneuver in this particular terrain database was extremely difficult and may have resulted in frequent mobility kills on manned vehicles putting them at a disadvantage with opposing force (OPFOR) maneuvering units.

Figure 2. Tank commander's crew station in the VIDS-equipped simulator.

3. Time was extremely constrained for conducting the numerous scenarios (i.e., 30 trials) and required continuous execution of missions throughout all events.

4. Constant re-initializing platoons between scenario events would have resulted in possibly excessive delays (due to hardware, software, and network breakdowns) and elevated frustration levels for the crews.

VIDS Description

The following section describes the VIDS basic functionality used in this experimental evaluation. This experiment employed six sensors, six countermeasures (CMs), and main gun counterfire (CF) arranged in four increasingly progressive arrays for increased vehicle survivability and lethality. The progressive array of these sensors and CMs were previously illustrated in Table 2. A short functional description of all sensors and CMs (including CF) are provided in Tables 4 and 5, respectively.

Threat Resolution Module (TRM)

The TRM, the "brain" of the system, was an artificial intelligence embodiment serving to initiate automatic CMs or to recommend actions to be taken by the TC. The TRM assigned pre-programmed priorities to detected threats according to different sensor detections and assigned the appropriate CMs (or the next appropriate available CM if simultaneous threats were sensed) accordingly. Up to ten prioritized threat sensings were capable of being displayed simultaneously with many more awaiting in the memory "queue" (which could be replaced by more threats as the system countered and deleted them from the queue). The latest and highest priority threat moved automatically to the top of the queue. The TRM

Table 4

Sensor Type and Description

Laser Warning Receiver (LWR)	The LWR sensor detected laser ranging, designating, and beam riding ATGMs. Coverage included 360 degrees azimuth and -10 to +40 degrees elevation. It provided threat type and bearing to the threat.
Missile Warning System (MWS)	The MWS sensor detected ATGM launches out to 6 km and provided the directional quadrant of launch. Coverage included 360 degrees azimuth and -10 to +40 degree elevation. It did not track the ATGM.
Non-Imaging System (NIS)	The NIS sensor detected the acoustic signature of the main and tail rotor blades of rotary wing aircraft. It had 360 degree azimuth coverage, detected out to 15 km, and identified the helicopter by 7 km. It predicted bearing to the aircraft as well.
Muzzle Flash Detector (MFD)	The MFD sensor detected tank muzzle flashes and provided the directional quadrant of launch. It did not track projectiles or tell the VIDS vehicle whether it was being targeted. Coverage included 360 degree azimuth and -10 to +40 degree elevation.
Tank Radar Warning Receiver (TRWR)	The TRWR sensor detected ATGMs using radio frequency (RF) uplinks. It gave bearing and elevation of the emitter as well as the mode (searching, tracking, and command uplink). Coverage included 240 degrees azimuth and -5 to +80 degrees elevation.
Future Armored System Radar (FASR)	The FASR sensor was an active radar system for armored vehicles used for target acquisition. The system searched, detected, and classified threat vehicle platforms occurring throughout a 90 degree sector at ranges of 200 to 5000 m. Coverage included 210 degrees azimuth and 0 to 10 degrees elevation.

responded to laser detections first because this meant a closer and more dangerous threat was present and targeting the vehicle. The first priority of countermeasure response was to use energy emitting CMs (i.e., MCD, CPS, and LCMD) when appropriate for the particular threat, present in a particular configuration, and available for use (in case of simultaneous engagements). Second priority of response was expendable CMs, i.e., smoke grenades, flares, and TCS projectiles. The last priority was always CF after all other CMs were engaged. Table 6 lists the TRM detection and CM/CF priority assignment scheme for the different VIDS configurations. The only threat platforms delivering munitions in this simulation were T-80 tanks launching AT-11 ATGMs and firing 125mm rounds, BRDMs launching AT-2 and AT-4 ATGMs, and HINDs launching AT-6 and AT-9 ATGMs.

Modes of Operation

Although VIDS was capable of operating in three modes (i.e., manual, automatic, and semi-automatic), only automatic and semi-automatic modes were used for this experiment. All sensors were operational in all modes and in all four VIDS configurations. Automatic mode was a "hands-off" mode whereby the CMs and CF actions were taken by the VIDS without intervention by the TC. In semi-automatic mode, CMs and CF actions were implemented by the VIDS only after the TC activated them with the CCH. Once activated, the CMs and CF functions continued to operate in automatic mode until all active threats became inactive or

were deleted from the system.

Table 5

Countermeasure (CM) Type and Description

Pedestal Operated Multi-Ammunition Launching System (POMALS)	The POMALS CM dispensed visual and IR smoke grenades to obscure and degrade optical and electro-optical signatures. IR/visual grenades degrade targeting by IR/electro-optical (EO) acquisition devices and IR terminally homing ATGMs. The simulated POMALS consisted of two independent slewing turret-mounted pedestals capable of covering 180 degrees to each side of the vehicle. Two grenades launched per salvo covered 30 degrees and required a total of 4 seconds to respond and cover the designated area.
Missile Countermeasure Device (MCD)	The MCD CM is an IR jammer that confused the tracking system of an incoming missile. It was effective against ATGMs with continuous wave or modulated IR tracking systems. The MCD had an elevation coverage of plus or minus 5 degrees, an azimuth coverage of plus or minus 18 degrees, and slewed independently from the turret.
Combat Protection System (CPS)	The CPS CM detected and countered EO guidance or tracking methods by using of a low energy laser mounted over the gun tube. For this simulation the effective coverage width was set to 20 degrees (10 degrees on each side of the gun tube). The CPS slewed independently from the turret and has effective azimuth coverage of 360 degrees and 0 to 30 degrees elevation coverage. The effective range was between 700 to 8000 m.
Laser Countermeasure Device (LCMD)	The LCMD CM projected a laser spot (on the ground) 30 m away from the vehicle to decoy laser designated (LD) ATGMs only. Effective coverage was 360 degrees.
Threat Countermeasure System (TCS)	The TCS CM was comprised of two major components: a vehicular radar that tracked incoming threat munitions, and a series of hull-mounted pods that launched pellets or rods that detonated or deflected ATGMs or main gun projectiles before reaching the vehicle. Effective coverage was 360 degrees azimuth and -10 to +90 degrees elevation with a detection range of 6 km.
Flares	The flares CM was available as a one-shot CM deployed at a 45 degree angle to degrade targeting of IR/EO acquisition devices and IR terminally homing ATGMs. Effective azimuth coverage was 202.5 degrees with flare duration of 4 seconds.
Main Gun Counterfire (CF)	Based on sensory input, the VIDS system slewed the turret within plus or minus 5 degrees of the detected threat and released it to the gunner for final sighting and engagement of any enemy detected. Accuracy of slew to threat was dependent on the accuracy of sensor input. Effective coverage was 360 degrees azimuth and -10 to +20 degrees elevation. Main gun accuracy was effective out to 3000 m.

Table 6

Threat Resolution Module (TRM) Logic for Vehicle Integrated Defense System (VIDS) Configurations: Countermeasure Selection Priority by Threat Type

Threat	Sensor	Countermeasure
Configuration 1		
AT-2 ATGM (RF Uplink)	MWS	MCD/POMALS
AT-4 ATGM (Wire Guided)	MWS	MCD/POMALS
AT-6 ATGM (RF Uplink)	MWS	MCD/POMALS
AT-9 ATGM (Laser Designated)	LWR/MWS	POMALS
AT-11 ATGM (Laser Beam Riding)	LWR/MWS	POMALS
125 mm main gun round	LWR	POMALS
Configuration 2		
AT-2 ATGM (RF Uplink)	MWS	MCD/POMALS
AT-4 ATGM (Wire Guided)	MWS	MCD/POMALS
AT-6 ATGM (RF Uplink)	MWS	MCD/POMALS
AT-9 ATGM (Laser Designated)	LWR/MWS	POMALS
AT-11 ATGM (Laser Beam Riding)	LWR/MWS	POMALS
125 mm main gun round	LWR	POMALS
Configuration 3		
AT-2 ATGM (RF Uplink)	TRWR/MWS	CPS/MCD/POMALS
AT-4 ATGM (Wire Guided)	MWS	CPS/MCD/POMALS
AT-6 ATGM (RF Uplink)	TRWR/MWS	CPS/MCD/POMALS
AT-9 ATGM (Laser Designated)	LWR/MWS	CPS/POMALS
AT-11 ATGM (Laser Beam Riding)	LWR/MWS	CPS/POMALS
125 mm main gun round	LWR	CPS/POMALS
Configuration 4		
AT-2 ATGM (RF Uplink)	TRWR/MWS	CPS/Flares/TCS
AT-4 ATGM (Wire Guided)	MWS	CPS/Flares/TCS
AT-6 ATGM (RF Uplink)	TRWR/MWS	CPS/TCS
AT-9 ATGM (Laser Designated)	LWR/MWS	CPS/LCMD/TCS
AT-11 ATGM (Laser Beam Riding)	LWR/MWS	CPS/TCS
125 mm main gun round	LWR/MFD	CPS/TCS

Note. ATGM = Anti-Tank Guided Missile; RF = Radio Frequency; MWS = Missile Warning System; LWR = Laser Warning System; TRWR = Tank Radar Warning Receiver; MFD = Muzzle Flash Detector; MCD = Missile Countermeasure Device; POMALS = Pedestal Operated Multi-Ammunition Launching System; CPS = Combat Protection System; TCS = Threat Countermeasure System; LCMD = Laser Countermeasure Device.

Commander's Controls and Display Panel (CCDP)

A 13-inch diagonal color computer monitor with a touch-sensitive overlay was mounted directly to the front of TC at his crewstation (see Figure 2). This touch-sensitive monitor, the CCDP, served as the primary interface with the VIDS in all four configurations. It included the tactical display and controls necessary to operate VIDS (except for the modified CCH). Figure 3 shows an example CCDP display from VIDS Configuration 3. The displays included graphic and composite formats indicating: (a) threat types and

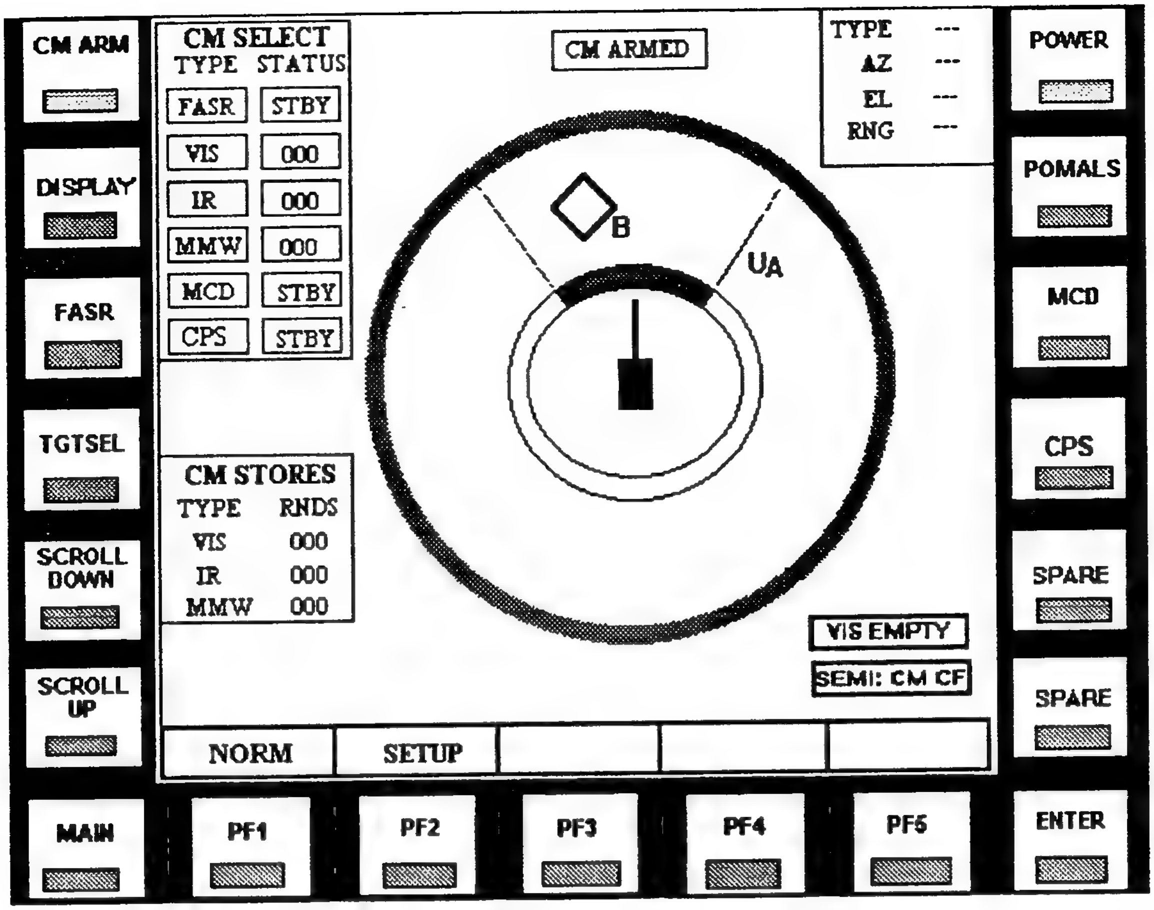

Figure 3. Schematic of the Commander's Controls and Display Panel (CCDP).

direction, (b) CM data fields giving status of currently selected CMs and remaining inventories of expendable CMS (i.e., smoke grenades, flares, and TCS), (c) armed or safe CM status, (d) threat position field information, (e) textual warning alerts when preset VIDS conditions were violated, and (e) textual display of current mode status. Panel controls (located vertically and horizontally on the edge of the tactical display) pertained to system functions and display adjustments. Interaction between the display and controls was accomplished by the TC through the use of the vertical fixed function keys and a horizontal programmable function key driven menu set. A brief overview of the CCDP features and functions is presented in the following paragraphs.

Tactical display. Battlefield information was displayed inside the large circle. Various threat symbols (icons) from the sensor readings of battlefield threats appeared in a 360 degree arc in relation to the tank hull symbol. The CCDP was non-directional in that the top of the screen did not represent the direction north, but represented the front of the vehicle hull. The hull, located in the center of the screen, always remained stationary while the turret/main gun tube (extended line from center block) could rotate 360 degrees. The turret and main gun tube icon indicated the turret/main gun line of sight (similar to the simulator's turret-to-hull reference indicator). The Alert Sector (outer circle) corresponded to the azimuth degree coverage of the sensors, i.e., 360 degrees. The CM Coverage Sector (inner circle) corresponded to the azimuth degree coverage of active CMs. The Threat Icon Field (area between the inner and outer circles) was where threat icons were displayed when threats were detected. Distance from the hull to the icon was not indicative of relative distance from the threat, but only indicated the general direction of the threat in relation to the hull. The shaded area with lines running at angles from the inner circle defined the programmable turret limits (which were disabled during this experiment).

Threat icons. In Figure 3, two threat icons are pictured to illustrate some examples of threats displayed

on the tactical display. In this example, a diamond with a "B" represented a threat platform firing a beam-riding ATGM (i.e., a T-80 firing an AT-11 ATGM) and a "U" with the lowered "A" represented an unknown platform launching an unclassified ATGM. Highest priority threats would blink on and off and could be replaced with a more recent higher priority threat at any time. Multiple different threat icons located in the same position would have the highest priority threat appear on top. Multiple threats of the same type in the same location would have double edges, e.g., a diamond within a diamond. Threats located in the same direction were sometimes reversed in distance; a threat further away may appear closer to the hull symbol than the relatively closer threat depending on the time it was detected. Threat icon positions were updated about every 30 seconds. (For a detailed listing of threat symbology used in the this BDS-D software refer to Appendix C, Page C-68).

Threat position field. This field (located in upper right hand corner of the tactical display) displayed the bearing (azimuth and elevation) of the highest priority (blinking) threat icon. The FASR (if present) displayed range information for moving objects (if moving more than 2 mph). The TRWR (if present) displayed RF weapon system status and bearing and range to the launching platform. As higher priority threats were detected, this field was updated.

CM status fields. Two CM status fields (located on the left side of the tactical display) displayed textual information about the current status of CMs (CM SELECT) and number of expendable CMs remaining in inventory (CM STORES). The CM SELECT field gave the number of expendables currently being discharged or gave the current status of energy emitting CMs (on or in standby mode). When a particular CM was activated, it highlighted briefly with a yellow light. The CM STORES field updated the inventory status field as expendable CMs were used. Only CMs appeared with numbers upon initialization in a particular VIDS configuration. For example, configuration 4 would not contain a listing of any smoke grenades, but listed 30 flares and eight TCS projectiles.

CM indicator. Located at the center top of the display is a CM indicator field. This field indicated the current armed (ready to counter) or safe (not armed) status of the configuration's CMs. CMs were always armed before starting training exercises and evaluation scenarios.

Alerts. There were two types of VIDS alerts: textual display warnings and audible alerts. The top field in the lower right hand corner gave warning messages when VIDS system parameters had been violated, e.g., certain types of grenades are exhausted. Audible alerts were either a short series of tones or a voice message. Alert tones were sounded over the crew intercom system and indicated a threat sensing. A female's voice message was sounded (i.e., VIDS is waiting) when a TC delayed implementing the VIDS during semi-automatic mode operations.

Mode indicator. The field located directly below the warning indicator indicated the active VIDS operating mode for CMs and CF. When the system was programmed in either automatic or semiautomatic mode, this indicator appeared displaying the status for the CM and CF.

Function keys. Except for the use of the CCH, all inputs to the VIDS system were entered via fixed function keys and programmable function keys. Fixed function keys were fixed functions just as their labels imply and were located vertically on the left and right side of the tactical display. Fixed function keys marked "SPARE" would be mapped to additional CMs as different VIDS configurations were initialized, i.e., in configuration 4 the LCMD CM would appear on one of the "SPARE" keys. Programmable function keys were located horizontally along the bottom of the display screen with functional labels appearing in display boxes above each key. Programmable function keys were programmable in that they would change function according to the menu selected. Both fixed function and programmable function keys were touchscreen sensitive buttons. The operator had to depress slightly with a finger below an indicated key to activate the function. If successfully depressed, the key would highlight a yellow bar indicating it had been turned on. Depressing the key again would turn it off and the button light would highlight black.

Fixed function key functions. Starting with the top left side, the CM ARM key indicated the system was

armed when the system was initialized and could be used to toggle all CMs to safe or armed status. The DISPLAY key could be used to delete all lower priority threat icons from the display (but not from the queue). The FASR key (only present in VIDS configurations 2, 3, and 4) was the only sensor key on the controls because it was an active emitting sensor. It was active all the time in this simulation but could be used to manually turn off the FASR. The TGTSEL key was used to delete selected icons from the screen (usually after a successful engagement). (The system automatically deleted inactive icons after 30 second of inactive status.) The SCROLL DOWN and SCROLL UP keys allowed the TC to move down or up through the threat priority queue to see threat priority order and obtain Threat Coordinate field information about the selected icons. Use of the scroll keys and the TGTSEL key allowed the TC to delete threats from the system that had been successfully countered or engaged. The MAIN key could be used to return to the top level menu (currently displayed in Figure 3) at any time from sub-menu operations.

Starting with the top right side key, the POWER key was depressed to turn the display interface on or off but did not affect VIDS system ongoing operations. The POMALS, MCD, and CPS keys were all CM keys that highlighted when the system used them or could be used to manually employ a CM at any time. The SPARE keys were placeholders for future operations or additional keys for mapping other CMS used in the different experimental configurations. The ENTER key was used to enter menu selections made by programmable function key inputs.

<u>Programmable function keys and menu functions</u>. Only two menus were used for purposes of this evaluation. The NORM menu or SETUP menu could be chosen by touching the PF1 and PF2 keys, respectively. Both of these choices were available from the current MAIN menu. The SETUP menu allowed the operator to set VIDS system parameters such as turret scan sectors, CM response sectors (for expendables like smoke grenades), beam width for CPS, sensor sectors, and safety sector zones for preventing CM and CF activations. Menu setup was standardized for all configurations and TCs were not allowed to use this menu before or during exercises and scenarios. All sensor and CM response sectors were fixed at 360 degrees and CPS was set to a 20 degree arc. No turret scan sectors or safety zone sectors were implemented.

The NORM menu was used to place the CM and CF into semi-automatic and automatic mode. (Turret slewing for scanning could also be implemented in either mode but was not selected for use in this experiment.) TCs were directed by the RA to place both CM and CF in either mode by selecting them using the appropriate PF key and using the ENTER fixed function key after each selection. Upon selection, the mode indicator field indicated the mode status of the CM and CF.

<u>Commander's Control Handle (CCH)</u>

The basic M1 CCH was modified with a thumb switch that allowed the TC to activate the VIDS system when operating in semi-automatic mode. Figure 4 illustrates a rear view diagram of the modified CCH. Notice the VIDS activation button is located on the upper right hand side. The TC could decide to activate the system recommendations indicated on the CCDP once the VIDS determined the vehicle had been targeted. When the system was activated, it operated in automatic mode until all threats were removed from the queue.

<u>Exercise Control Center (ECC) Systems</u>

The stations that monitored and controlled the training events, training exercises, training scenarios, and test scenarios were located in the ECC. These stations consisted of : (a) an "electronic clipboard" terminal, (b) one semi-automated forces (SAFOR) workstation (WS), (c) a Management, Command, and Control (MCC) terminal, (d) a SIMNET Control Console (SCC), (e) a Fire Support Element (FSE) terminal, (f) one SINGARS simulator, (g) a Stealth station with a Plan View Display (PVD), and (h) a "phantom" terminal.

The "electronic clipboard" was used by the Battle Master to flag starting and ending events during test

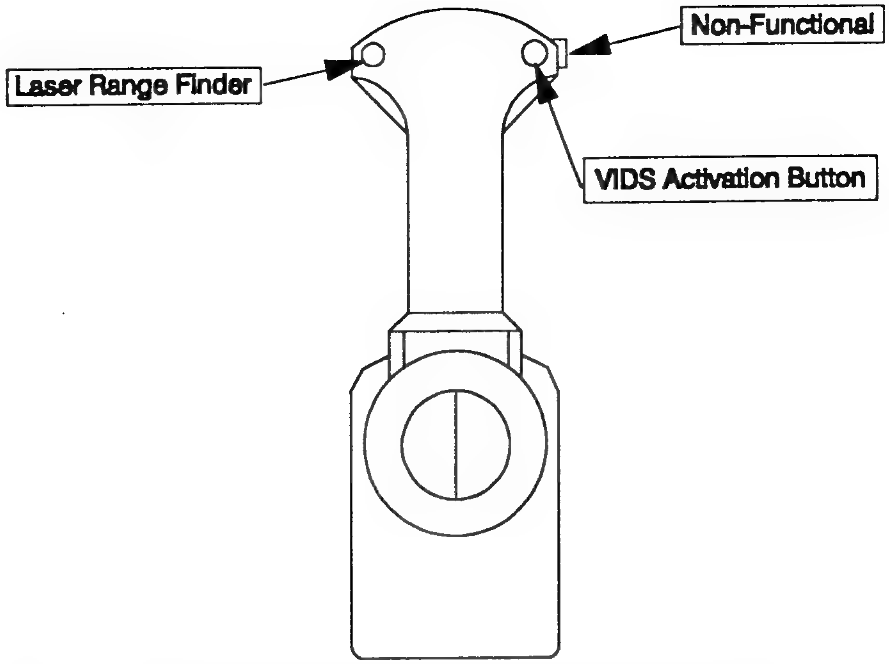

Figure 4. Modified M1 Commander's Control Handle (CCH) for VIDS.

scenario execution. The SAFOR WS was used by the SAFOR operator to control the simulation-generated opposing forces (OPFOR). The MCC system (with SCC) was used to monitor and control the simulation. The FSE terminal was used by the SAFOR operator to perform indirect fire missions for the platoon. The SINGARS was used by the Co Cdr and Battle Master to communicate with different elements in the platoon. The Stealth station with accompanying PVD was controlled by the assistant Battle Master and used to monitor the virtual battlefield from various viewpoints to assist execution of events, exercises, and scenarios. A "phantom" terminal was used to monitor the status of SIMNET activities such as data traffic transmissions. A brief description of each of these systems follows. More detailed descriptions of this equipment can be found in Du Bois and Smith (1989), Leibrecht, Kerins, Ainslie, Sawyer, Childs, and Doherty (1992), O'Brien et al (1992), and Leibrecht et al (1993).

Electronic Clipboard

The electronic clipboard consisted of a personal computer with software for developing a preformatted file for scenario execution events. The scenario events were preprogrammed in three files representing the three test scenarios. The files contained sequentially coded start and stop markers for flagging (inserting time markers) into the SIMNET data stream to mark the beginning and ending of specific events in each scenario. Other coded markers were available to flag critical or significant events (e.g., simulator malfunctions) for later analysis. The Battle Master started the clipboard when the data logging system was started and terminated clipboard operations after the final scenario event.

SAFOR WS

A single SAFOR WS was used by the operator to control and monitor the status of the OPFOR during training and testing. The WS provided a top-down color map view of the simulated battlefield. The operator could move and zoom in on any point in the map display. Features such as contour lines, grid coordinates, natural terrain (water and trees), constructed objects (railroad tracks, bridges, and roads), and control measures and overlays were capable of being displayed for control of movement and fire. The WS keyboard was used to set engagement distance rules and cross country rates of maneuver. Initialization files for each training event, exercise, scenario and test scenarios allowed OPFOR units to be automatically placed

in starting locations with keyboard commands. The SAFOR WS operator directed the activities of the OPFOR in accordance with the established standardized operating guidelines and rules, event lists, scenarios and guidance of the Battle Master.

MCC System

The MCC system allowed the control staff (i.e., assistant Battle Master, SAFOR operator, or contract team manager) to initialize and manage the simulation. Initialization involved defining the terrain database, the exercise identifier, simulator parameters, and unit organization. Files were established for calling up initialization parameters which allowed the control staff to retrieve and execute events, exercises, and scenarios in a standardized manner. After initialization, the MCC provided information for monitoring the status of the manned simulators.

SCC

The SCC was a component of the MCC system. It was used by the control staff to initiate the MCC's involvement in any event, exercise, or scenario and initialize any elements simulated by the MCC system. The SCC allowed the control staff to place vehicles (manned simulators) and gunnery targets in specific database locations. Standardized files, created by the control staff, were retrieved by keyboard commands to place all vehicles and targets on the database. During any event, exercise, or scenario execution, the SCC provided the capability to reconstitute (restore) any elements that may have malfunctioned or dropped off the network. In addition, ammunition, fuel, and vehicle information status could be obtained.

FSE Terminal

The FSE was used by the SAFOR operator to provide indirect fire support at the direction of the Co Cdr (who received requests from the Plt Ldr). The operator of the FSE terminal could readily access type of fire support, number of salvos, and deliver the munitions to specific grid locations on the database.

SINGARS Simulated Radio

A simulated SINGARS radio net was used by the Co Cdr to provide voice communications with the Plt Ldr and Plt Sgt. While training was conducted, the SINGARS radio was used to coordinate training activities with the RAs and TCs. During test scenarios, it was used by the Co Cdr to relay timely battlefield information like fragmentary orders (FRAGOs), intelligence reports, reports on enemy activity (keyed to scenario events), and give orders and direction to the platoon. In addition, it was used by the Battle Master to monitor platoon communications for CONTACT reports (which were flagged via the electronic clipboard). Throughout training and test execution, the radio network was used by control center personnel, crewmembers, and RAs to identify and isolate simulator, simulation, and VIDS simulation problems.

Stealth Station

The Stealth station consisted of a large screen projection display and an associated PVD, keyboard, and trac-ball (a hand control for maneuvering three dimensionally in the virtual terrain). This station, controlled by the assistant battlemaster, provided the primary monitoring capability used in training and testing execution. The large screen monitor and trac-ball provided the control staff with the capability to move three dimensionally on the virtual battlefield and monitor real-time events from any angle or view. Almost all simulated elements and actions (such as vehicle and aircraft movement, gunnery, artillery impacts, burning vehicles, etc.) were displayed. All VIDS simulated CMs (smoke, flares, and TCS projectiles), although present in the simulation, were not visually represented on the Stealth display.

The PVD provided the capability to monitor the simulation from a "bird's-eye" view of the virtual battlefield. Like the SAFOR WS monitor, it was capable of displaying color-coded digital terrain with details like rivers, roads, and geographic features. It also had the capability to display color coded icons

representing manned and OPFOR vehicles and aircraft, all moving and firing events, direct fire locations, and artillery fire impacts. The PVD allowed the operator to add and remove map features, get elevation and map coordinates at any point, zoom in and out any area, acquire intervisiblity readings between any points (including vehicles), and choose vehicles to obtain their identity, location, speed, and bearing. This information was relayed upon request to the Battle Master, Co Cdr, SAFOR operator, and Evaluation Director for training and test execution and manual data collection.

Phantom Monitor

The Phantom monitor was used to monitor the status of the network. Lines of code and data packets were displayed on the monitor as training and testing events transpired. In this evaluation, its primary use was for monitoring the network status and identifying the OPFOR vehicles that were firepower killed by the VIDS CPS countermeasure.

Automated Data Collection and Analysis (DCA) System

This subsection provides a very brief description of the DCA system. Readers requiring a more detailed description of the DCA features are referred to Du Bois and Smith (1989). In this evaluation, the DCA supported automated collection, reduction, management, and analysis of soldier performance data. The system consisted of (a) a Data Logger for collecting and recording data packets generated automatically by the network or manually via the electronic clipboard, (b) DataProbe software for extracting and reducing the data from the Data Logger recordings into data files, and (c) RS/1 statistical software for conducting analysis of data from files created by the DataProbe software. (DataProbe and RS/1 software are registered trademarks of Bolt, Beranek, and Newman, Inc.) Primary examples of data collected, reduced, and extracted for analysis were each vehicle's hits and kills by munitions type, ATGM firings and impacts, manned vehicle hits and kills on OPFOR vehicles, CPS firepower kills on OPFOR vehicles and aircraft, etc. Contracted analytical support personnel utilized this system to develop the final data files for further reduction and analysis by the evaluation team's data management personnel.

Training

Participant training for the VIDS experiment involved a "crawl-walk-run" design, beginning with individual training on equipment, progressing through crew practice, and culminating in platoon exercises.

Individual training emphasized M1 simulator operation, MWTB navigation, and VIDS operation. The individual training was composed of classroom briefings, demonstrations, and guided hands-on practice in the simulators. All participants received an introductory briefing, conceptual overview demonstration of an operating VIDS prototype, an M1 simulator briefing, and a demonstration of the VIDS CCDP interface. Seat specific training for TCs, gunners, and drivers involved crew station orientation and brief guided practice sessions. Vehicle commanders received specific VIDS orientation training via briefings (with viewgraphs) and hands-on training in the various VIDS configurations and modes.

Crew integration training consisted of putting crews in individual virtual "sandboxes" (Winsch, Atwood, Sawyer, Quinkert, Heiden, Smith, and Schwartz, 1994) to conduct tactical navigation exercises with target engagements. Crews had the opportunity to develop their collective skills during this phase of training. When MWTB navigation was mastered, crews (in VIDS-configured simulators) were placed in different locations where they underwent increasingly more difficult threat engagement opportunities. Throughout both types of crew integration training, they were required to report battlefield activity using standard reporting formats.

Unit training consisted of exercising platoons under conditions similar to evaluation conditions. Platoons used the baseline and various VIDS configured M1 simulators to practice realistic combat operations in defensive and offensive situational training exercises (STXs). After completing a platoon STX, a debrief was conducted. The sequence of unit training exercises allowed crewmembers to further hone their individual

skills, practice crew coordination, and develop coordination skills as a platoon while performing platoon combat missions.

The multiple stages of training required a variety of materials. These included lecture-style materials for classroom sessions, VIDS demonstration materials, script-like outlines for individual hands-on training and practice, hands-on diagnostic VIDS test for TCs, trainer checklists for crew and unit training, platoon standing operating procedures (SOP), training STX materials, and a VIDS job aid.

Classroom Briefings

For classroom instruction, viewgraphs with scripts were used to standardize presentations. Classroom instruction packages included: (a) an introduction and overview explaining the VIDS evaluation program, the evaluation's purpose and objectives, the general approach and methodology, schedule of weekly events, MWTB layout and rules, and privacy considerations; (b) a MWTB simulation orientation comparing and contrasting the simulators to the actual M1 tank, explaining unique simulator features and operating conditions and emphasizing key equipment components; (c) a SIMNET navigation briefing explaining SIMNET map reading, protractor usage, dead reckoning, terrain association, resection, and polar plotting; (d) a VIDS overview briefing explaining VIDS capabilities and operational features, illustrated examples of VIDS defensive capabilities against threats, and VIDS experimental test configurations.

VIDS Demonstrations

There were two demonstrations of VIDS: a conceptual demonstration during the introductory classroom session and a VIDS CCDP interface demonstration following the VIDS overview briefing. The VIDS concept demonstration consisted of a working VIDS model (i.e., the Eglin VIDS prototype emulator) on loan from TARDEC. This model consisted of: (a) a tank mounted to the top of a round tubular plexiglass housing with a motorized gunner's sight camera capable of rotating 360 degrees and elevating about 20 degrees, (b) a control panel and display much like the CCDP illustration in Figure 3 except the display fields were superimposed over a through-sight video picture, and (c) cadillac controls with thumb buttons for controlling the sight and VIDS initiation of CMs and/or CF. Three threat pictures were placed on the walls of the classroom and the VIDS model was preprogrammed to "engage" the threats with simulated launchings of smoke grenades and CF .

The CCDP interface demonstration was presented to all participants in the simulator bay area. The CCDP demonstration consisted of a scripted presentation of the applied functions and features of the VIDS CCDP (see Figure 3). A large rear-screen projection monitor was used to show a CCDP screen from a nearby simulator. An operator in the simulator manipulated the CCDP in synchronization with the instructor's presentation (see Appendix C) to allow demonstration of a complete interaction.

Seat-Specific Guides

Training outlines (see Appendix C) were adapted from previous crew station training outlines used in prior test bed research. These training outlines, geared to emphasizing differences between the actual and simulated tank, were used to orient small groups to their respective crew stations (TCs, gunners, and drivers). The outlines included practice on selected tasks appropriate for the crew station and assigned crew member. These outlines insured standardized seat-specific orientations were given to all participants.

Hands-On Training Outlines

The RAs used a two-phased training outline to conduct individual VIDS familiarization training with the TCs. The outlines listed the points to be made and VIDS features and equipment functions to be explained, demonstrated, and practiced. These outlines ensured the standardized presentation of instruction to all the TCs. The first phase focused on the basic orientation to the CCDP, the sensors, and CMs. The second phase focused on the use of the VIDS equipment in semi-automatic and automatic mode. A sequence of

events was followed for VIDS equipment functions: explanation of the functions purpose, followed by a step-by-step explanation and demonstration, and ending with hands-on practice. For the first phase, the TCs practiced using and reading the CCDP. In the second phase, the TCs practiced semi-automatic and automatic mode operations of specific VIDS functions against eight simulated threat presentations (similar to what the TCs would later receive in training exercises). The second training phase was followed by a diagnostic test. The diagnostic test was used as a gate to determine if the TCs were ready to proceed to crew training. The RAs used test results to determine if TCs needed additional training in specific areas. In addition, the test results were used to provide feedback about the training program effectiveness.

Crew Training Exercise Logs and Checklists

Crew training consisted of two exercises that allowed practice on navigation, maneuver, and gunnery with and without VIDS. Crews performed both exercises within virtual sandboxes with predetermined checkpoints. (Detailed sandbox descriptions and procedures are explained in the Crew Training sub-section in the Procedures section of this report.) The Battle Master directed crews to proceed to numbered checkpoints, recorded their arrival in a controller log, and verified their reported coordinates against coordinates of their location from the PVD. For this navigation and crew training, the RAs used a crew training checklist (see Appendix C) to observe crew and navigation performance and provide guidance and retraining on navigation-related and gunnery tasks. For crew integration training with VIDS configurations 3 and 4, a crew integration checklist (see Appendix C) was used by the RAs to observe listed performance on navigation, radio reporting, crew interaction, and VIDS operation.

Platoon SOP Appendix

The platoon SOP appendix was a supplement keyed to individual paragraphs in the standard Tank Platoon SOP (U.S. Army Armor School, 1991). This supplement provided more detailed guideline information to existing sections or replaced corresponding sections of the SOP, and was given to TCs to use during training and testing. The guidelines specifically addressed changes in command and control and tactical operations due to VIDS and the simulation environment (see Appendix E).

Platoon Situational Training Exercises (STXs)

The situations, events, and target arrays comprising the defensive and offensive STXs were specified in scenarios developed by the evaluation team's armor SMEs (i.e., the Battle Master and Co Cdr) and approved by the DCD, U.S. Army Armor Center. Based on current warfighting doctrine, the STX scenarios contained defensive and offensive platoon missions built around blocks of threat events fought on the Hunter-Ligget terrain database (later utilized for test scenarios). The defensive STX contained 25 threat event presentations that were evenly divided into five blocks corresponding to a baseline and four VIDS configurations. The offensive STX contained 15 threat event presentations that were divided into five blocks corresponding to the baseline and four VIDS configurations. In both offensive and defensive STXs, the platoon received opportunities to train on two baseline configurations and on each VIDS configuration in automatic and semi-automatic mode. Each STX was designed to take two and three-quarter hours to execute. Event lists and control files were used by the ECC staff to execute and control both STXs. Doctrinally correct OPORDs were briefed to platoons detailing the tactical situation prior to execution and served as a basis for the platoon to plan its tactical execution. Prior to the start of each block within the STX, crews received refresher training on the specific configuration and the platoon received a brief FRAGO before execution. Appendix C contains platoon training materials including STX event lists and OPORDS for both defensive and offensive STXs.

During platoon STX execution, a checklist served to remind the trainer (RA) of the individual, crew integration, and VIDS-related tasks the crewmembers were supposed to practice. Both defensive and offensive checklists contained three areas of functional items keyed to a particular configuration block used in the STX event list. The three functional areas were: (a) target detection, acquisition, and engagement; (b) communication; and (c) crew integration. Listing each functional action item separately, the checklist

called for the RA to either mark an item a plus (+) if it was performed, a minus (-) if it was not performed, or "NA" if it was not applicable to any of the events within a particular configuration block. During the exercise and reconfiguration breaks, the RA could prompt and correct individual crewmembers, respectively, about their performance (or non-performance) of a particular action. Copies of these checklists appear in Appendix D.

Job Aids

Each TC used a set of materials to help him navigate during crew integration and platoon training. These included: SIMNET terrain maps (housed in clear plastic with cardboard backing), re-usable hand-drawn operations overlays on clear acetate (with clear acetate covers for notations), duct tape for securing overlays and covers to the map, and map protractors (with ruler) for plotting azimuths and measuring distances. Additionally, to assist the TC in remembering VIDS specifics during training (and later during test execution), a hip-pocket VIDS job aid was developed. The job aid was given to the TCs during the CCDP demonstration for reference and they were allowed to use them during training and testing. The job aid contained brief one page sections of VIDS terminology, VIDS component definitions, threat icon symbology, short descriptions of the baseline and each VIDS configurations' components, plus tactical capabilities and limitations. A copy of the job aid can be found in Appendix C.

Test Scenarios

Test scenarios consisted of a number of realistic force-on-force encounters designed to evaluate the tank platoon's defensive and offensive capabilities as they maneuvered and fought in the simulated combat environment. Training and Doctrine Command (TRADOC) approved scenarios were modified by SMEs in DCD, using current warfighting doctrine and realistic threat array possibilities. The associated documents (OPORDS, operational terms, and graphic overlays) were reviewed and approved by SMEs in the 16th Cavalry Division's Platoon Doctrine Branch. All scenarios were designed for the Hunter-Ligget database and required one hour (plus or minus 15 minutes) to execute, excluding initial planning time and breaks.

To provide the opportunity to stress the various VIDS configurations and capture the resulting platoon performance data, scenarios were constructed around three basic small unit operations: movement to contact, hasty attack, and hasty defense. These operations were chosen because they required the platoon to use the VIDS in both offensive and defensive operations against a variety of threat arrays and would fully exercise the various VIDS sensors and CMs. Three scenarios consisting of ten discrete engagement events were developed to provide repetitive measurements of platoon performance under offensive and defensive operations. All three scenarios contained the same events but were arranged in different sequences. Two scenarios portrayed operations flowing from south to north and one scenario from north to south on the same terrain. Each engagement event in each scenario was constructed to maintain equivalence of key parameters: number of OPFOR vehicles, weapon types, engagement ranges, target dispersions, and movement distances. OPFOR fire parameters, engagement criteria, and vulnerabilities were identical between scenarios. Scenario events were structured to flow seamlessly so participants would perceive them as continuous. Table 7 and Figure 5 together provide an example of the first scenario (Scenario 1) portrayed in the evaluation. Events in Table 7 are numerically keyed to the circled numbers within the operational overlay depicted in the map in Figure 5. Appendix F contains associated documentation to provide further details of the scenario execution.

The OPFOR presentation was modelled after doctrine outlined in FM 100-2-1, Soviet Army Operations and Tactics (U.S. Department of the Army, 1989). The mix of forces provided the maximum number of platforms from which the different OPFOR weapons could be operated: HIND helicopters delivered AT-6 and AT-9 ATGMs, T-80 tanks delivered 125mm main gun rounds and AT-11 ATGMs, and BRDMs delivered either AT-2 or AT-4 ATGMs.

Each scenario included a set of tactical control documents used to brief the platoon and initiate the planning process. These documents, the OPORD and graphic overlays, provided the platoon with their

Table 7

Engagement Events in Scenario 1

Events	Event action
1	BLUFOR reports REDCON 1; engages OPFOR recon platoon (3 BDRMs).
2	BLUFOR ambushed by a BDRM with AT-4 ATGMs after crossing LD/LC.
3	BLUFOR recons ambush site; attacked by a HIND-F with AT-6 ATGMs.
4	BLUFOR passes PL Rock; attacked by 3 HIND-Fs with AT-6 ATGMs.
5	BLUFOR moves to CP 12; conducts Meeting Engagement enroute: attacks 3 T-80 tanks with 125mm munitions.
6	BLUFOR continues mission; attacked by 2 HIND-Fs with AT-9 ATGMs.
7	BLUFOR occupies CP 12; performs Hasty Defense against OPFOR tank company with AT-11 ATGMs and 125mm munitions.
8	BLUFOR engages 3 enemy T-80 tanks crossing sector.
9	BLUFOR ordered to CP 16; 3 T-80s engage with AT-11 ATGMs.
10	BLUFOR conducts Hasty Attack against 2 BRDMs with AT-4 ATGMs.

Note. BLUFOR = Blue Forces; REDCON = Readiness Condition; OPFOR = Opposing Forces; BDRM = Soviet Armored Reconnaissance Scout Vehicle; AT = Anti-Tank; ATGM = Anti-Tank Guided Missile; LD = Line of Departure; LC = Line of Contact; HIND-F = Soviet Attack Helicopter; PL = Phase Line; CP = Check Point; T-80 = Soviet Main Battle Tank.

objectives, the context for their operations, and the minimum necessary guidance for conducting operations. The OPORDS were planned in sufficient detail to allow the Plt Ldr to begin immediate planning of mission execution. Additional materials supporting mission execution included: SIMNET maps of the battlefield terrain framed in cardboard with acetate covers; prepared overlays affixed to the battlefield maps; acetate covers and grease pencils for drawing over the overlays and maps; duct tape for affixing blank acetate over the overlays; and map protractors with distance ruler.

Computer files, controlling the initial placement of simulators for all scenarios, were used for standardizing the start of scenario execution. Also, computer files of each scenario's overlay were digitally created to assist ECC control personnel in standardizing the monitoring and execution of the scenarios.

Manual Data Collection Instruments

A variety of instruments served to collect soldier self-report and research team observational data. These instruments included soldier-completed questionnaires, and RA and armor SME observation logs. A listing of the instruments, their description and purpose are displayed in Table 8. Appendix G and D include the actual questionnaires and observational logs, respectively.

The instruments (with the exception of the Structured Group Debrief) were adapted from similar

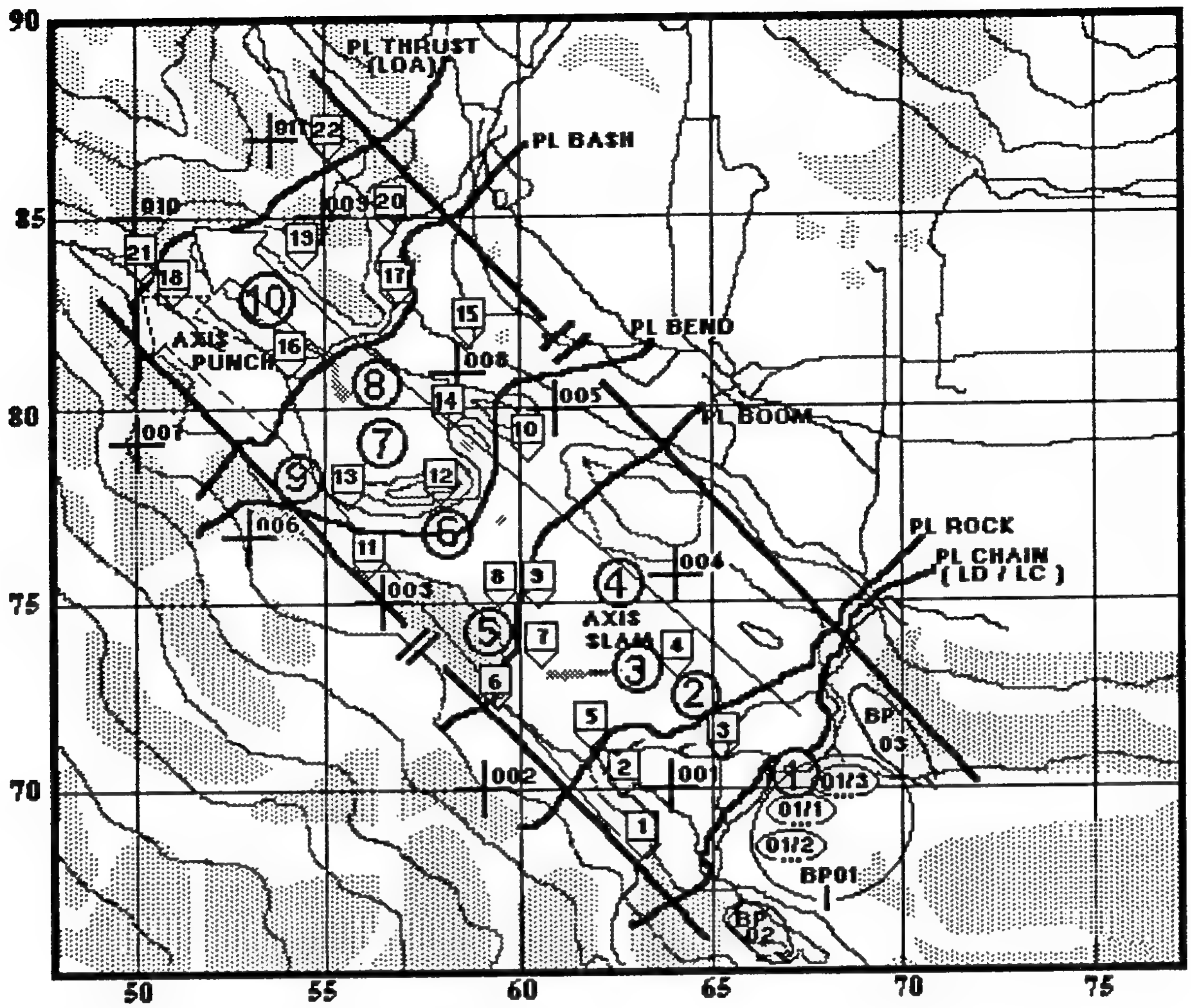

Figure 5. Map with operational overlay for scenario 1.

questionnaires used in previous MWTB research efforts (BDM Federal, Inc., 1993; Atwood, Quinkert, Campbell, Lameier, Leibrecht, and Doherty, 1991; Morey, Wigginton, and O'Brien, 1992). Workload tasks for the workload assessment instrument were derived from Field Manual 17-15, Tank Platoon (U.S. Army Armor School, 1991) and STP 17-19EK4-SM, Soldier's Manual, Armor Platoon Sergeant, MOS 19E and 19K, Skill Level 4 (U.S. Department of the Army, 1989).

Procedures

Prior to the start of the evaluation, a six-week period of hardware-software functional testing and pilot evaluation testing occurred. VIDS associated hardware and software was functionally tested for three weeks with subsequent modifications made prior to the initiation of the pilot evaluation. RA training on VIDS and their roles as trainers took place during the functional testing time-frame during which time they served as trainees and support personnel. Immediately following the functional test, a two-week pilot evaluation test occurred. The RAs trained soldiers from the 194th Separate Armor Brigade, and the ECC staff had the opportunity execute evaluation scenarios. After the pilot test, one week was used to correct and modify training and testing materials, procedures, and finalize the hardware and software fixes identified in the functional and pilot testing.

Table 8

Summary of Manual Data Collection Instruments

Instrument	Description	Purpose
Biographical questionnaire	Questionnaire for collecting armor soldier demographic and experience data. Completed by all soldiers.	Describe the sample and assess, post hoc, test group equivalence.
Training evaluation questionnaire	Questionnaire for assessing soldiers reactions to the training program and identify training effectiveness and future implications. Completed by all soldiers.	Evaluate training program effectiveness and training requirements.
Workload assessment questionnaire	Questionnaire to assess Plt Ldr and TC task workload. Completed by TCs.	Evaluate differential task workload distribution attributed to VIDS configurations.
Soldier-machine interface (SMI) questionnaire	Questionnaire to assess perceptions about the acceptability and usefulness of VIDS components and features. Completed by TCs.	Identify VIDS design issues and requirements.
VIDS tactical questionnaire	Questionnaire to assess effectiveness of VIDS and its features and components in tactical operations. Completed by TCs.	Identify VIDS tactical capabilities/limitations and associated TTPs.
SME journal/questionnaire	Cumulative record and questionnaire for collecting observations about VIDS tactical effectiveness and usefulness of its features. Completed by ECC armor SMEs.	Identify VIDS tactical capabilities/limitations and associated TTPs.
VIDS RA log	Log to record RA observations about TC and crew, equipment usage, and technical problems. Completed by RA.	Primarily used to identify differential equipment usage attributable to differing configurations.
Structured group debrief	After action review (AAR) record to capture soldier's summative reactions to VIDS, tactical operations, training, SMI, potential TTPs, and the evaluation procedures. Completed by RAs.	Identify various VIDS capabilities/limitations, training and SMI issues, and future evaluation recommendations.

Note. Plt Ldr = Platoon Leader; TC = Tank Commander; VIDS = Vehicle Integrated Defense System; ECC = Exercise Control Center; SME = Subject Matter Expert; TTP = Tactics, Techniques, and Procedures; RA = Research Assistant.

This subsection describes the methods and procedures used to conduct the evaluation. The following procedural description is organized to focus on: training of the participants, scenario execution, data collection, and data management, reduction, and analysis.

Training and Evaluation Schedule

Training and testing each group of participants took 10 days over a two-week period. The first 2 1/2 days of the first week were used for the training phase in which participants received individual, crew, and platoon training. The next 6 1/2 days were used for executing evaluation scenarios. The final day was reserved for make-up, post hoc simulation excursions, a debrief, and final questionnaire administration. The training and evaluation schedule is depicted in Figure 6.

	MONDAY DAY 01	TUESDAY DAY 02	WEDNESDAY DAY 03	THURSDAY DAY 04	FRIDAY DAY 05
0800	Introduction	VIDS Hands-On Tng	PLT STX OFF Brief	1st Condition	2nd Condition
	Tank vs. Simulator	VIDS Hands-On Tng	OFF STX Execution		
	Navigation Brief	VIDS Skills Test	OFF STX Execution		3rd Condition
	Seat Specific Tng	Crew Tng	OFF STX Execution		
	Navigation Exercise	Crew Tng	OFF STX Execution		
1200	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1300	VIDS Overview	PLT DEF STX Brief	OFF STX Debrief	2nd Condition	3rd Condition
	VIDS CCDP Demo	DEF STX Execution	TNG Ques Admin		
	VIDS Hands-on Tng	DEF STX Execution	Start Test Execution		Make-up
	VIDS Round Table	DEF STX Debrief	or make-up Tng		
1700					

	MONDAY DAY 06	TUESDAY DAY 07	WEDNESDAY DAY 08	THURSDAY DAY 09	FRIDAY DAY 10
0800	4th Condition	5th Condition	7th Condition	9th Condition	Make-up
		6th Condition	8th Condition		Excursions
1200	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1300	5th Condition	6th Condition	8th Condition	10th Condition	Debrief/ Ques Admin
		7th Condition			Excursions
1700					

Figure 6. Block representation of the bi-weekly training and evaluation schedule for participants.

As can be seen in the schedule, test scenarios began on the first Wednesday afternoon and proceeded through the second Thursday afternoon. A total of 30 scenarios were conducted within this time-frame with usually no more than five conducted in any given day to prevent fatigue. (There were six occasions in which six to seven per day were conducted due to the temporary loss of a TC and an unannounced training holiday.) Three scenarios were conducted per condition; condition representing a particular vehicle configuration and mode. Baseline conditions were always run in the first and tenth condition. This design was used to provide an overall conservative test for the effects of VIDs in relation to baseline performance. The average of the first and last baseline performances would provide a more robust estimate of true baseline performance by removing sequence and learning effects.

During training and testing, crews were assigned to the same simulator and crew members were not allowed to exchange positions. RAs remained with the same crew throughout training and testing, except for switching simulators to more objectively conduct TC skill testing.

Participant Training

Training of participants was designed to prepare the crew members to operate the equipment, develop basic operational skills as individuals and crews, and prepare the platoon for executing the test scenarios. Training involved a "crawl-walk-run" design, beginning with individual training on equipment, progressing through crew practice, and culminating in platoon exercises. Individual training was much more extensive for TCs than for gunners and drivers because they were the primary operators of the VIDS. A detailed description of the participant training is presented in the following sections.

Individual Training

Individual training started on Monday (Day 01) with the Battle Master assigning participants to crews based on roster information and current unit duty assignments. After crew assignments, a classroom overview explaining the background, purpose, general methods, and administrative guidelines for the VIDS evaluation effort was conducted by the Evaluation Director. The classroom overview presentation included a VIDS model emulator demonstration for introduction of the VIDS concept. At the conclusion of the briefing, a privacy act statement and a biographical questionnaire was administered to all participants. Following a short break, all participants received a classroom viewgraph presentation from the Co Cdr highlighting the components of the MWTB simulation and the M1 simulator including any differences between it and the actual M1 tank. Immediately following this presentation the drivers and gunners proceeded to seat specific training while the TCs remained in the classroom for a navigation briefing conducted by the Battle Master. The navigation briefing consisted of a viewgraph presentation with practical exercises designed to reinforce navigation techniques.

During the TC navigation briefing, the RAs conducted one-on-two hands-on training in the simulators with the gunners and drivers. In this session, the four gunners and four drivers were paired with one RA each (i.e., two drivers or two gunners) and then each pair received explanations of the simulators features and functions. After receiving specific crew station training, each gunner and driver briefly practiced gunnery or driving tasks, respectively. After their practice session, all were given a break until crew training started.

After the navigation classroom training, the TCs took a short break and proceeded to the simulators for their seat specific hands-on training. RAs conducted one-on-one training on the features and functions of the TC crew station, including a brief overview of the VIDS equipment. A set of practice tasks ended the session, with the RA allowing the TCs to practice the task as much as possible before prompting them with the correct response. After this session,the TCs were allowed a short break. After the break, the crews assembled for their first crew training, the navigation exercise. (Procedures for this training follows in the Crew Training procedures section).

Individual training continued in the afternoon with a VIDS sensors and countermeasures overview presentation to all crew members. The Battle Master conducted a viewgraph-based briefing explaining the capabilities and limitations of the sensors and countermeasures, examples of their tactical use, the four VIDS suite configurations, and the operational modes. In addition, a brief videotape of the Eglin AFB field demonstration of the prototype VIDS was shown (Loral Vought Systems Corp., 1992). After this briefing, the crews moved to the rear of the simulator bay to observe a large screen monitor presentation about the VIDS CCDP. The Evaluation Director, with the help of the research analyst, used a script and FM walkie-talkie headsets to coordinate CCDP button pushes made in the simulator that were displayed on the large screen monitor. Using this method, the Evaluation Director explained and demonstrated the display's information fields, the functions of the fixed and programmable function keys, navigating the menu, and presented examples of their use. At this time, the TCs received a VIDS job aid (Appendix C) and were referred to sections on CCDP threat symbology. Upon conclusion of this demonstration, the crews were

given a short break.

After the break, gunners and drivers returned to the classroom for a roundtable discussion of VIDS and how it might affect their specific operations. The Battle Master and Test Director led the discussion, emphasizing key points about reactions to VIDS audible alerts, battle drill execution, gunner's actions, and driver's actions. Gunners and drivers were allowed to ask additional questions about the VIDS and request clarification on any discussion points made in the session before being excused from training for the day.

While the gunners and drivers participated in the roundtable discussion, the TCs received one-on-one hands-on VIDS training in their assigned simulators. RAs used scripted material that gave explanations of specific features and functions culminating each time in a practice event before proceeding to the next section of training. The hands-on training was divided into two phases: the first phase focused on basic characteristics of the VIDS CCDP, sensors, and countermeasures and the second phase focused on the threat symbology, VIDS operations in the two different modes, and practice events using VIDS in semi-automatic and automatic mode. By the end of the first day, most TCs had completed phase one and had proceeded to phase two before being excused. On Tuesday morning (Day 02) the TCs finished phase two by completing VIDS practice events. Upon completion of the hands-on training, the TCs were allowed any additional practice they thought they would need before proceeding to the VIDS skill test.

At this point, RAs changed simulators and tested a different TC than he had trained. RAs emphasized the VIDS skill test was not a judgement of their performance, but a method to ensure they had received proper training and the opportunity to remedy any areas they felt needed improvement. The test was composed of some verbal response questions and hands-on tasks (see Appendix C). The RA used a scripted test with correct answers and sequence of procedural task steps for guidance in scoring and feedback. If the TC answered and performed correctly, the RA marked a "GO" beside the particular test item. The RA informed the TC of the outcome of each item or task as they proceeded. For final task item performance in both modes of operation, the TC was given the opportunity for remediation on either task (if he failed to perform it correctly) by performing the task sequence on an alternate event. Remedial training was provided as necessary.

Crew Training

The first session of crew training took place during the navigation exercise Monday morning (Day 01) when crews were assembled for the first time. Each crew (using the baseline M1 configuration) practiced negotiating terrain, identifying locations and friendly and enemy targets, acquired and engaged enemy targets, and practiced giving radio reports. Using a 5 km by 5 km "sandbox" terrain setting, each crew navigated a six waypoint route laid out on their maps in their assigned sandbox. RAs used a task-oriented checklist to observe and record strengths and weaknesses of individual crew member and crew performance. During the exercise, the RAs prompted TCs when they overlooked or ignored some function or task and ensured the TCs used some of the different navigation techniques practiced during the classroom section. Stationary friendly and enemy targets were placed on the terrain to cue identification and trigger target engagements if enemy targets were encountered. TCs were instructed to send CONTACT and SPOT reports to the exercise controller and Battle Master for events encountered and location reports upon reaching checkpoints. Upon completion of the sandbox, the RAs used the checklist record to provide individual and crew performance feedback. If the RA and Battle Master thought a crew needed additional training, the crew was initialized into another sandbox and given the opportunity to practice in that one.

On Tuesday morning (Day 02), crews were assembled after the TCs completed their VIDS Skills Test. Similar to the navigation exercise, the crew integration exercise allowed the crews to practice the same tasks as before but using VIDS configurations 3 and 4. The RAs utilized a task-oriented crew integration checklist to observe and record individual and crew performance. As before, the RAs prompted the TCs if they failed to perform some function or task and, when asked, freely provided guidance and information to all crewmembers. All four crews were located at opposing ends of the Hunter-Ligget terrain database. First, crews were initialized in VIDS configuration 3 and established in defensive positions. RAs directed the TCs

to place their VIDS into automatic mode. Various weapons platforms and munitions (identical to the arrays they would face later in the evaluation) were directed against two diagonally opposing crews simultaneously. After their engagement was completed, the remaining two diagonally opposing crews received the same threat array engagement. This was done because it was manageable by the one OPFOR controller on one terrain database. After a pair of crews completed their engagement, the RAs informed the exercise controller and Battle Master that they were ready for another engagement and directed the TC to place his VIDS into semi-automatic mode. Each crew received two engagement opportunities in this configuration, one for each operational mode. At the conclusion of both engagements, the RA used the checklist record to provide individual crew members and crew with feedback on their performance.

Crews were given a short in-simulator break while the simulators were re-configured into VIDS configuration 4. At this point, TCs were instructed to place their systems into semi-automatic mode and proceed to move out according to the heading directed by the Battle Master. Each crew encountered the identical target array at some point along their passage. Upon the conclusion of their first engagement, the RAs directed them to place the VIDS into automatic mode and keep moving. After conducting a second engagement against identical threat arrays, RAs provided individual and crew performance feedback according to their checklist record of performance. Crews were dismissed for lunch at the conclusion of their crew feedback session.

Platoon Training

Tuesday afternoon (Day 02) the platoon situational training exercises (STXs) began. This training focused on platoon mission performance in defensive and offensive operations. The defensive STX was conducted that afternoon and the offensive STX was conducted Wednesday morning (Day 03). Both STXs were initiated when the Co Cdr or Battle Master briefed the mission to the platoon using an OPORD and graphic overlay materials. Briefings were conducted in the classroom. Mapboards with prepared graphic overlays covered with clear acetate were provided to each TC. In this way, no TC had to spend time drawing graphics. After questions were answered by the Co Cdr or the Battle Master, the Plt Ldr was given 15 minutes to plan for the STX mission. After planning, the crews moved to the simulators and conducted pre-operational checks, including intercom and radio nets, intra-crew coordination, and platoon coordination. After 10 to 15 min, STX execution began. The Battle Master, Co Cdr, OPFOR operator, and Assistant Battle Master conducted the STXs using events lists with prepared OPFOR initialization files and OPFOR rules and ranges of engagement. RAs were provided with defensive and offensive STX events lists and checklists keyed to each configuration to assist them in their crew training. RAs observed and recorded crew performance and prompted TCs and other crew members when it appeared they were not performing essential tasks. As in crew training, the RAs freely provided guidance and answered any questions. During STX execution, short breaks were taken to allow the simulators to be reconfigured for each scheduled configuration. During reconfiguration, the RAs provided feedback to the crews on their performance. After completion of each STX, the platoon returned to the classroom and received a one-half hour debrief about the platoon's performance during specific engagements, VIDS configurations, and modes of operation. Soldiers were encouraged to ask questions about any aspect of the operations, especially VIDS operations.

Defensive STX. The defensive STX required 2 hr 45 min to execute, including short breaks for reconfiguring the simulators. Twenty five engagements were executed with the platoon remaining in the same battle position. The platoon was allowed some maneuver on the position, but were restricted from moving forward to engage the enemy. Five engagements were allotted per configuration and mode in the following order: baseline, configuration 1 in semi-automatic mode, configuration 2 in automatic mode, configuration 3 in semi-automatic mode, and configuration 4 in automatic mode. Weapons platforms and munitions were identical to what would be faced in evaluation scenarios, but in some instances the threat force was increased to challenge the platoon later in the STX execution. The Co Cdr provided FRAGOS, intelligence updates, and tactical guidance to the Plt Ldr. While in defensive positions, the Co Cdr and RAs encouraged the Plt Ldr and other TCs to continue using standard platoon battle drills, i.e., using hull defilade and maneuvering into slightly different positions after each engagement. The platoon returned to the classroom where they received a one-half hour debriefing on their defensive STX performance before being

dismissed for the day.

Offensive STX. The offensive STX was conducted Wednesday morning (Day 03). It required 3 hr 45 min to execute including breaks for reconfiguring simulators and two rest breaks for soldiers. Fifteen engagements were executed during platoon maneuvers. The platoon maneuvered in accordance with the original OPORD then changed maneuver direction according to pre-planned FRAGOs given by the Co Cdr. Three engagements were allotted per configuration and mode in the following order: baseline, configuration 1 in automatic mode, configuration 2 in semi-automatic mode, configuration 3 in automatic mode, and configuration 4 in semi-automatic mode. The platoon performed meeting engagements, hasty attacks, and hasty defense operations across the fifteen engagements, and encountered similar threat arrays which they would later encounter in the evaluation scenarios. The Co Cdr and RAs continued to provide prompts and guidance to the Plt Ldr and TCs, respectively, to reinforce effective use of the VIDS and continual use of battle drills, i.e.,using terrain in movement and evading ATGMs with sagger drills. The platoon was dismissed for lunch and upon returning to the classroom, received a one-half hour debriefing on their offensive STX performance. At the conclusion of the debriefing, the Evaluation Director administered a training evaluation questionnaire to all soldiers. Upon completing the questionnaire, the soldiers were allowed a 15 min break before starting test execution.

Evaluation Procedures

The testing stage of this evaluation consisted of executing ten sets of three test scenarios per evaluation cycle. The detailed scenario explained in the previous Test Scenario section serves as an example of how all three scenarios were executed. Each scenario required the platoon to conduct a movement to contact, using current doctrine, against an OPFOR composed of heavy armor and attack aircraft equipped with advanced technology ATGMs. All three scenarios were composed of the same identical ten discrete events, but executed in a different sequence on different routes on the same terrain, i.e. two south to north and one north to south. Execution procedures were the same for all three scenarios.

Scenario execution resulted in generating the automated operational performance data and provided opportunity for the collection of some manual data, i.e.,TC resource usage and SME observations. To control for possible learning and sequence effects, scenario order was counterbalanced across configurations and mode across the four different test cycles. (Refer to Appendix H for the evaluation schedules.) For the most part, only five scenarios were executed per day. Of the 24 possible sets of five executions per day, there were six instances in which five per day was exceeded (across three different evaluation cycles) and six instances of less than five per day were executed. No scenarios were carried over breaks, lunch, or to another day. After every set of three scenarios were conducted (representing the completion of a test condition), task workload assessment questionnaires were administered to the Plt Ldr and all TCs while the gunners and drivers were on break. Occasionally, some scenarios were interrupted due to equipment malfunctions, but were re-started approximately where they were interrupted. On rare occasions, some engagement events were restarted over again due to a catastrophic network failure. At the conclusion of all evaluation scenarios, "freeplay" excursions were conducted. Prior to the freeplay excursions, the Plt Ldr and TCs chose an optimal configuration and mode they preferred as a group. The platoon then used their chosen configuration during execution of an additional three evaluation scenarios. Automated data were not collected for evaluation during these excursions, but SMEs observed platoon behaviors during these excursions for insights into possible TTP development.

At two points during the evaluation scenario execution, the platoon was given short motivational presentations designed to offset the effects of scenario familiarization and stress. After about a third of the scenarios were executed, the first classroom discussion was held either Friday evening (Day 05) after the last scheduled scenario or prior to the first scenario executed the following Monday morning (Day 06). During this session, discussion points included: the use of kill suppress for data collection, the importance of role playing, and frustrating effects of equipment or simulator malfunctions. A second session emphasizing the continued use of role playing was conducted about two thirds of the way through the scenario schedule. This session was conducted Tuesday evening (Day 07) or Wednesday morning (Day 08) of the second week.

In contrast to their roles during training, the RAs were only allowed to ensure that the TC initially placed and then remained in the correct operational mode, collected observational data, and monitored simulator and VIDS equipment status. The RAs were not allowed to coach or respond to crew members questions, but were allowed to alert the ECC personnel if equipment problems occurred.

Unit Planning Procedures

The orders briefings, conducted by the Co Cdr (or Battle Master role playing the Co Cdr), were initially conducted in the classroom fifteen minutes prior to the in-simulator start time. TCs waited outside the classroom and the gunners and drivers proceeded to the simulator bay to conduct pre-operational checks on their assigned simulator. The Plt Ldr received a map mounted on a mapboard, an overlay, clear acetate, tape, marking pens, and map protractor. The entire OPORD was briefed in detail with the aid of the map and overlay. At the conclusion of the briefing, the Plt Ldr was allowed to ask any questions to clarify points made during the brief. After the Plt Ldr indicated he was ready to brief his TCs, the TCs were called in to the classroom and given the same materials the Plt Ldr had received. The Plt Ldr then briefed his TCs from his notes giving them his intent for the operations. At the conclusion of their brief, the Plt Ldr and TCs proceeded to the simulators and briefed their crews. After multiple repetitions of the three scenario briefings, the planning process was shortened to less than 5 min and was conducted outside the simulators to save execution time.

The scenario OPORDs and predrawn overlays provided to the TCs were designed to shorten the planning and preparation process, minimize tactical decision making, and focus the platoon on implementing the mission. This process standardized the tactical approach to the mission and helped eliminate any potential differences between experienced and inexperienced planners.

Unit Preparation Procedures

The Assistant Battle Master initialized all four simulators using prepared MCC and SCC computer files to place the platoon in a pre-configured arrangement on the terrain database prior to the start of any of the scenarios. Pre-operational checks and procedures were performed by the RAs, gunners, and drivers prior to the TCs' arrival to their simulators. After briefing their crews, the TCs performed radio checks with the Plt Ldr and the ECC. Any problems were corrected prior to the platoon indicating readiness to proceed. Once all TCs had indicated their equipment was ready, the Plt Ldr gave the Co Cdr a REDCON-1 report.

Execution Procedures

ECC control personnel used prepared computer files to retrieve the OPFOR into the appropriate start positions on the terrain database. Decision rules for starting, controlling the OPFOR, and concluding an event were utilized by the SAFOR controller to ensure standardized presentation was performed across scenarios.

The Battle Master and Co Cdr monitored the large Stealth station screen and relied on the SAFOR controller and the Assistant Battle Master to inform them of ranges, current operating status, imminent OPFOR firings, and any other specific parameters that helped monitor the progress of the scenario events. The scenario started when the first friendly tank of the platoon crossed the line of departure. At this point the Co Cdr gave a brief FRAGO and intelligence report in accordance with an event list. All ECC personnel including the Battle Master, SAFOR controller, Co Cdr, and Assistant Battle Master had descriptive scenario event lists that outlined the event action (including Co Cdr orders to the platoon), enemy action describing the specific event action, and the threat array the platoon would encounter (Appendix F). The Battle Master ordered the initiation of certain events (e.g., OPFOR movement speed) based on the OPFOR location and movement, the platoon's location and movement, and each forces' location in respect to specific control measures. The SAFOR controller and Assistant Battle Master provided the specific information for those decisions based on their PVD displays and readouts at the SAFOR workstation and Stealth station.

The Battle Master controlled the scenario execution and automated data collection process. During scenario execution, he used a set of contingency rules (Appendix I) to execute control of scenario events and provide guidance to the SAFOR operator. For data collection, he used the electronic clipboard to flag significant events as the platoon maneuvered and fought in the different scenario events. He inserted digital marks for scenario beginning and ending times, event starts, CONTACT report times, significant events (i.e., equipment malfunctions), and event ending times into the Data Logger data stream which was used later for data reduction.

The SAFOR operator used his workstation to control all OPFOR movement, conduct indirect fire support, and place vehicles on the terrain. He used his PVD to monitor the scenario progress from a "birds-eye" view of the battlefield. Programmed files were used to standardize OPFOR numbers and types, unit placements, movement and firing parameters, and competency levels for OPFOR direct fire. He controlled the timing of OPFOR activities during each event, based on the Battle Master guidance and the platoon's actions.

The Assistant Battle Master maintained the Stealth view of the battlefield for the ECC staff. He also monitored his PVD to provide range indications of firing events, manned simulator locations, and status of manned simulators to the Battle Master. In addition, he used the MCC and SCC to initialize the manned simulators, determined the nature of equipment malfunctions and problems, summoned technicians for assistance in solving the problems, assisted in resetting simulator configurations, and provided tactical and guidance and advice to the Battle Master.

SAFOR Fire Initiation Procedures

OPFOR elements were capable of delivering direct fire with tank munitions or ATGMs. Maximum and minimum ranges were set for direct fire in SAFOR initialization files. The ranges were based on threat munitions ranges provided by SMEs in the Threat Division of DCD. The maximum range for OPFOR tank engagements was established at 2000 m. ATGM maximum engagement range parameters were based on the specific ATGM type and the threat platforms line of sight to platoon elements. BRDMs could engage with AT-2 and AT-4 ATGMs within 2500 m. HIND helicopters engaged with AT-6 and AT-9 ATGMs within 6000 m. T-80 tanks engaged with AT-11s within 3500 m. OPFOR tank firing parameters were set to a moderate level of gunnery effectiveness, but ATGMs were set to hit if they could maintain a direct line of sight for the required in-flight time.

The platoon could engage whenever they visually acquired the enemy. Probabilities of hit and kill were dependent upon the range of engagement and according to the moderate fire engagement setting. Indirect fires, although pre-determined to be non-effective, were allowed when the Plt Ldr called for them and the Co Cdr agreed that it was appropriate for the situation, i.e., an OPFOR company attack. Indirect fire was delivered by the SAFOR controller by using a "bomb" button function at his terminal.

Platoon Control Procedures

The Co Cdr provided direction to the Plt Ldr and platoon through reports and orders. His role was similar to what a Co Cdr would do in the field environment. In some cases, he directed the platoon on certain routes and to certain positions to standardize the platoon's placement in order to engage the target array within the appropriate range parameters. On occasion, he redirected lost elements in the platoon who became separated due to terrain maneuver, disorientation, or were reinitialized on the database. When the platoon was completely off their course heading, stopped for an inappropriate amount of time, or an element become separated, the Co Cdr would check with the Assistant Battle Master, determine their specific location, and give a bearing and some landmark orientation to the Plt Ldr. This process continued until the platoon was back on course and all elements were present. The Co Cdr exercised as much tactical realism as possible when communicating with the platoon. He did not "coach" the Plt Ldrs during the scenarios, but did provide corrective orders and motivational statements at appropriate junctures during maneuver and engagement events.

Contingency Procedures

Occasionally, problems occurred with the simulation network, simulator hardware and software, radio communications, power problems, and non-availability of participants. To ensure consistent and standardized handling of those problems, a set of decision guidelines was developed to guide the decision process of the Evaluation Director in consultation with the Battle Master. Courses of action were chosen based on the impact they had on the (a) consistent execution of the experiment and its impact on quality and completeness of the data, (b) realistic execution of the scenario, (c) the impact it would have on the test schedule, and (d) the impact on the platoon's execution of the rest of the scenario and events. In general, the options available to resolve these problems included: (a) delaying the start of the scenario until problems were fixed or replacement gunners or drivers were on site, (b) suspending execution of the scenario until a temporary problem was fixed, (c) dropping a crew and operating as a three-tank platoon until the simulator was fixed or until the TC returned, and (d) dropping a crew to maintain the critical positions of the Plt Ldr and Plt Sgt. Delays were the usual option preferred, especially when the test schedule had room for delays. Delaying and replacing gunners and drivers was the next most preferred option. Executing scenarios with a three-tank platoon was the last resort.

Notes detailing when the problem occurred, a description of the problem, and the decision made were documented by the Evaluation Director in his log book and used to ensure adjustments were made later (if needed) in data analysis. If the problem occurred during the execution of an event, the Battle Master flagged the start and end of the problem and recorded an electronic note. When the problem impacted the platoon, the Plt Ldr and TCs were briefed on the modifications before implementing them.

Short term equipment problems required the crews to break in place and take breaks within the simulator. Longer term problems (i.e., longer than 10 minutes) resulted in the crews being released to the break area or classroom until the problem was fixed. Once the problem was fixed, crews returned, did quick pre-operational checks, indicated REDCON-1, and resumed their mission.

When the VIDS interface went down on a simulator, the crew continued to operate since the VIDS would still respond without the display. If a simulator crashed, the platoon continued the event if already engaged then ceased operations at the conclusion of the event. If a simulator dropped off the network, the same procedure was used. Upon the simulator's return to operation, the platoon element was re-initialized near the other elements, directed to their location, and resumed their mission.

Debriefing Procedures

After all 30 evaluation scenarios and the three excursion scenarios were completed, the platoon returned to the classroom for a structured group debriefing (see Appendix J for the outline). Prior to the start, the Evaluation Director cautioned that they would be videotaped and encouraged their participation in the discussion to follow. At this point, videotaping began and the Battle Master conducted the debriefing. The debriefing consisted of: discussion of specific threat events and their performance using various VIDS sensors and CMs, crew commentary about reactions to VIDS during operations, and discussion of their favorability and ideas for improving VIDS features and functions, training, and experiment execution. After the debriefing was concluded, gunners and drivers were dismissed while the Plt Ldr and TCs remained to complete questionnaires on soldier-machine interface (SMI) issues and tactical use of the VIDS. Once they completed the questionnaires, they were dismissed.

Data Collection Procedures

Automated Data Collection

Automated data was captured during the execution of the scenarios and was processed by employees of Loral Advanced Distributed Simulations (LADS). Standard Data Logger procedures were used. All executed scenario performance was recorded on magnetic tapes in the morning and afternoon then

subsequently reduced for analysis. Each scenario consisted of ten unique engagement events. For each engagement event, an ASCII file was created which contained event start, ending, and CONTACT report times and data identifiers (i.e., evaluation cycle, trial number, configuration, mode, scenario, and event). Standardized ASCII files containing the sequence of events were started prior to each scenario with the Battle Master inserting (time flagging) the event codes into the data stream. Electronic notes were inserted to explain significant anomalies (i.e., delays) for later retrieval during data reduction.

Manual Data Collection

The Evaluation Director, RAs, Battle Master, and Co Cdr participated in manual data collection. The Evaluation Director administered all participant completed questionnaires. RAs used observation logs to record TC equipment usage data and monitor crew interactions, and debrief outlines to record their assigned crews' comments during the debriefing. The Battle Master and Co Cdr kept SME journals of tactical ratings and used these to record their final observations into an SME questionnaire.

The Evaluation Director administered all questionnaires in a group setting in the classroom. The biographical questionnaire was administered to all participants at the conclusion of the introductory briefing. Upon conclusion of training and prior to the first evaluation scenario briefing, a training evaluation questionnaire tailored to the TCs, the gunners, and drivers was completed. After this point, only the Plt Ldr and TCs completed the remaining questionnaires. Workload assessments were completed by the Plt Ldr and TCs after the conclusion of each tested configuration (i.e., every three scenarios). After the final debriefing, the Plt Ldr and TCs completed a SMI and VIDS tactical questionnaire, in that order.

RAs logs were completed during each scenario based on the RAs' observations of the TCs' equipment operation and crew interactions. They advised the crew members that the log was not being used to score their performance, but to collect research data. During the debriefing, each RA recorded significant comments made by crew members assigned to their simulator.

The two research team's armor SMEs, the Battle Master, and Co Cdr recorded their observations in an SME journal during and immediately after each tested condition. At the end of all ten tested conditions per evaluation cycle, they summarized their comments in SME questionnaires. The journals and questionnaires contained their observations about VIDS employment on the battlefield.

Data Reduction and Analysis Procedures

The privacy of individual soldier information was protected by storing all manual instruments with names and social security numbers within a locked file cabinet. Only the roster, crew assignment sheet, and biographical questionnaire contained this information. All other questionnaires were labelled by participants with their simulator number (or radio call sign) and their duty position. The last four digits served to identify individual cases in all later database activities.

Data reduction and analysis proceeded through four steps: database management, data reduction, descriptive analysis, and inferential analysis.

Database management. For automated data collected by the Data Logger, databases were created by the LADS personnel using a VAX computer and data extraction routines. LADS data analysis personnel used Data Probe software to extract raw data from the magnetic tapes containing the recorded scenario data into data files. Once files were established, they used RS/1 routines to extract the required data for the time intervals specified in the electronic clipboard ASCII files. These files were intermediate only and required further reduction.

Data from the manual data collection instruments were established and organized into database files using the Data Entry II module of the Statistical Package for the Social Sciences for the IBM Personal Computer (SPSS/PC+) (SPSS, Inc., 1990). One file per manual data collection instrument was established

with written comments being placed in word processing files. The evaluation team's research analyst created data entry screens on the personal computer and inputted all data with a keyboard. Before saving each file, the research analyst scanned the entries and double-checked their accuracy against the original data collection forms.

Database reduction. Automated data reduction was performed by both LADS personnel and the Data Manager. LADS analysts used RS/1 routines to create specified intermediate measures data (for later computation) and operational performance measure data. The reduced data files were given to the evaluation team's Data Manager for loading into a pre-formatted Microsoft Excel (Microsoft Corp., 1992) spreadsheet program. This program provided the structure for loading the data into SPSS for Windows (SPSS, Inc., 1993) statistical software package. After being loaded into the statistical package, the data were scanned for out-of-range values, skewed distributions, and anomalous data values (i.e., kill data exceeding the number of enemy vehicles in an engagement). Suspicious data findings resulting from these control checks were returned to the LADS personnel for correction. Corrected data were re-examined and accepted if data results appeared within logical parameters. Otherwise, the data were dropped from consideration for further analysis. At this point, the Data Manager calculated final performance measures from intermediate measures. Following this procedure, individual vehicle data were combined into platoon data. The end product of this process was one SPSS file with all the platoon automated performance measures.

Once again, the research analyst performed quality control checks on all manual data entered into database files. Using SPSS/PC+ (SPSS, Inc., 1990), data were crosschecked for out-of-range, missing, and inconsistent values. If anomalies were found, data collection forms were retrieved and re-examined for correct entry into the database file.

Descriptive analysis. Prior to submitting automated and manual data for analysis, procedures were used for handling missing and contaminated data. Missing data resulted from a variety of reasons including: (a) VIDS defensive systems caused gunnery and missile range, hit, and kill data to be missing when OPFOR platforms "lost" sight of their target, (b) equipment and simulation failures, or (c) missing crew data from a key participant's absence. Contaminated data resulted usually from equipment malfunctions such as: (a) simulation overload during excessive smoke elements causing triple bursts on target, (b) indestructible SAFOR vehicles resulting in numerous friendly firings and hits for an event, (c) occasional unexplainable and unrealistic OPFOR fire rates, (d) erratic missile behavior, and (e) erroneous event flagging or typographical errors in the electronic clipboard file. For manual data, participants sometimes skipped a question item which resulted in missing data. The rule for missing data was to leave it as missing for future analysis.

Contaminated data were handled on a case-by-case basis. If it was possible to identify specific engagement events from the Evaluation Directors journal record notes, corrections were manually made to the database. For example, when triple burst occurred, the trials were identified and given to the LADS personnel to run and extract data from those trials with corrective factors added to the routines to correct the data counts. If erroneous event flagging occurred, usually resulting in spillover of different weapon systems into other engagement events, these trials were identified and time flags and typographical errors corrected for re-extraction of the data. Remaining contaminated data that were extreme in value were either adjusted to correlated data or from notes in the Evaluation Director's journal, i.e., if the number of kills exceeded the number of hits or possible number of OPFOR vehicles during an engagement. Unfortunately, not all contaminated data could be identified and separated from the data in a performance measure. If the violations appeared to be infrequent, the data remained but would contribute to error variation. If the data appeared to be frequent, the measure containing the data was dropped from further analysis.

All individual data were combined into platoon aggregate data. For some measures, the mean of the four platoons' performance served as the data point for the platoon. In other measures, the maximum performance by one tank served as the representative data element for the platoon. (See Appendix K for the specific definitions for measure aggregation.)

SPSS/PC+ (SPSS, Inc., 1990) was used for conducting all data analysis. Data analysis included:

computing distributions, means, standard deviations, minimum and maximum values, and generating frequency breakouts and response distributions to questionnaire and log data.

Inferential analysis. Operational performance measure and workload assessment data were subjected to parametric analysis with key independent variables. Analysis of variance (ANOVA) procedures were used to analyze individual performance measures and workload assessment ratings. These analysis were run using the Multivariate Analysis of Variance (MANOVA) procedure to conduct within-subject ANOVAs for individual measures (Stevens, 1992).

Independent variables of interest for analyses conducted on operational performance data were: (a) a simulator configuration variable which included the baseline and four VIDS configurations of sensors and CMs; (b) a mode of operations variable which included semi-automatic and automatic modes; (c) a scenario variable which included three different (although similar) scenarios; (d) an events variable which included ten different engagement events; and (e) a block variable that compared the first half of the evaluation trials to the second half to test for learning effects. Primary interest was focused on the main effects for all these variables and only those interactions considered relevant to the experiment. Two-way interactions of interest included: configuration by mode, configuration by event, mode by event, configuration by block, and mode by block. Scenario interactions were not of interest because events were the same across scenarios. Higher order interactions were not considered of relevance because of the low probability of detecting differences with this small a sample size.

Independent variables of interest for workload assessment data included only the configuration and mode variables. Because the workload assessment contains six subscales, only a few primary independent variables could be examined statistically.

An overall probability level of .10 was required to test for statistical significance because of (a) the reduced statistical power associated with the small sample size and (b) the use of two-stage ANOVAS due to the unbalanced design (Stevens, 1992, p. 456). In practical terms, this meant that each ANOVA was tested at the .05 level of significance. Multiple comparison tests (Bonferoni t tests) were conducted at less than .05 levels of significance (Stevens, 1992, p. 160).

EVALUATION MEASURES

This section describes the approach used in developing the measures and their description. These measures were used to provide data for addressing the four evaluation issues cited earlier in this report. Automated performance measures and manual measures are described in each subsection.

Approach

A variety of measures were adapted or developed for this evaluation. Many of the automated and manual measures reported here were adapted from previous MWTB research efforts. Some manual measures were further developed for this VIDS effort.

Automated Operational Performance Measures

During the initial phases of this joint evaluation effort, the working committee decided that vehicle survivability and lethality were the primary functional categories that a force protection system would affect during combat operations. Based on this decision, literature searches of past MWTB research were conducted to develop an initial list of measures fitting these categories. Previous VIDS research (BDM Federal, Inc., 1993) served as the primary source for an initial list. One review document summarizing previous MWTB research at the lower echelon levels (Elliott & Quinkert, 1993) provided some additional lethality measures and some ideas for refining more lethality measures. Most of the other research literature contained measures at the battalion level, or contained measures not pertinent to the two

categories.

During the early stages of the evaluation (functional testing and pilot testing) many measures were dropped because they could not be implemented accurately in the simulation network. For example, vehicle intervisibility was not blocked by smoke. As such, any time measures associated with decreasing intervisibility time were not possible. Other measures were considered duplicative and reduced from several to one.

At this point, the measures were still listed in either the survivability or the lethality category. In this evaluation, survivability was contingent on avoiding high technology ATGMs, tank munitions, or friendly direct fire. Theoretically, the VIDS CM systems would enhance a vehicle's capability to avoid all direct fire munitions and the sensors should assist in knowing where enemy and friendly units are located. Thus, measures were divided into main gun survivability, ATGM survivability, and fratricide measures. Lethality was a measure of the platoon's ability to destroy the enemy by performing basic gunnery actions, i.e., detect, identify, acquire, and engage the enemy successfully. The VIDS sensors would enhance the capability to detect, locate, and acquire the enemy quicker and at longer ranges, thus increasing the capability to destroy the enemy sooner and at longer ranges. Measures for lethality were divided into two main sub-categories to reflect these capabilities: (a) detection and (b) acquisition and engagement.

Manual Measures

Manual measures consisted of data items taken from the questionnaires and logs developed for this evaluation. Although operational performance was a key concern in this evaluation, training, SMI, and TTP issues were other key concerns. Many of the questionnaires and logs were adapted from the previous VIDS and MWTB research efforts.

Training measures. Measures for this issue were designed to capture information on training program effectiveness and future training requirements and issues. Training effectiveness measures were primarily designed to come from the skills test assessment scores, items on the training evaluation questionnaire, and feedback acquired from soldier comments during their final debrief.

SMI measures. Measures for this issue were designed to capture TC reactions to the introduction of the VIDS into their crew station and its impact on their tasks and operations. SMI measures consisted of equipment usage ratings, task workload assessment ratings, SMI questionnaire items, and soldier feedback at the final debriefing.

TTP measures. Measures in this key area were primarily qualitative in nature. Subjective judgements about the use of VIDS in tactical situations were designed to be gathered from armor SME observers and the participants. Subjective data were captured via SME questionnaires, a VIDS Tactical questionnaire given to TCs, and soldier comments to structured items in the final debrief.

Description

Automated Operational Performance Measures

The measures described in this section are the final set of measures that survived initial cuts and data reduction procedures. Remaining measures were subjected to statistical scrutiny before being included for inferential analysis. Four survivability measures and three lethality measures were dropped prior to the start of data analysis because they were highly inter-correlated with remaining measures.

Survivability measures. This category of measures relate to the capability of the platoon to survive on the lethal battlefield created in these scenarios. For clarity, the measures are sub-divided into four areas related to the type of threats that could affect platoon survivability (see Table 9). Main threats to survivability were designed to come from OPFOR main gun fire and ATGM attacks. Fratricide measures

Table 9

List of Survivability Measures

Measure	Condition
<u>Main Gun</u>	
Number of rounds fired at BLUFOR	(VIDS, M1 Baseline)
Number of BLUFOR hits taken from OPFOR rounds	(VIDS, M1 Baseline)
Number of BLUFOR kills taken from OPFOR rounds	(VIDS, M1 Baseline)
Range of main gun hits taken	(VIDS, M1 Baseline)
Range of main gun kills taken	(VIDS, M1 Baseline)
<u>ATGM</u>	
Number of ATGMs fired	(VIDS, M1 Baseline)
Number of ATGM hits taken	(VIDS, M1 Baseline)
Range of ATGM hits taken	(VIDS, M1 Baseline)
<u>All Munitions</u>	
Total time to hit taken	(VIDS, M1 Baseline)
<u>Fratricide</u>	
BLUFOR lases to BLUFOR	(VIDS, M1 Baseline)
BLUFOR firings on BLUFOR	(VIDS, M1 Baseline)
BLUFOR hits on BLUFOR	(VIDS, M1 Baseline)
BLUFOR kills on BLUFOR	(VIDS, M1 Baseline)
BLUFOR CPS firings on BLUFOR	(VIDS only)
BLUFOR CPS kills on BLUFOR	(VIDS only)

<u>Note.</u> BLUFOR = Blue Forces; OPFOR = Opposing Forces; ATGM = Anti-Tank Guided Missile; CPS = Combat Protection System; VIDS = Vehicle Integrated Defense System.

were included to evaluate the friendly fire threat to survivability. The survivability measure category contains 15 measures, two of which are exclusive to VIDS only. There are five measures relating to main gun threats, three measures relating to ATGM threats, one measure related to all OPFOR munitions, and six measures related to fratricide events. No ATGM kill measures were included because hits usually resulted in a catastrophic kill in this simulation.

<u>Lethality measures</u>. Representing the capability of the platoon's lethality, this category contained measures associated with two critical aspects of gunnery: detection and acquisition and engagement (see Table 10). Detection measures were adapted and developed to capture the capability of the platoon to detect threats which allows the platoon to orient and rapidly close and destroy threats. Acquisition and engagement measures were the second half of that equation and were measures of the platoon's effectiveness and efficiency at destroying detected enemy threats. There are eight measures contained in this category. Three measures are detection measures and five are acquisition and engagement measures.

<u>Manual Measures</u>

<u>Training</u>. Data for addressing training issues and requirements were collected from three primary sources: (a) TC's performance on their VIDS skill assessment at the end of individual training, (b) participant ratings and comments on their training questionnaires administered at the end of all preparatory

training, and (c) participant comments to directed training questions during their final group debriefing. Table 11 contains a listing of training measure data sources. (Appendix G contains copies of the training evaluation questionnaires.)

Table 10

List of Lethality Measures

Measure	Condition
Detection	
Time to first reported enemy contact	(VIDS, M1 Baseline)
Time from reported enemy contact until first round fired	(VIDS, M1 Baseline)
Range of first lase	(VIDS, M1 Baseline)
Acquisition and Engagement	
Number of hits per round on OPFOR	(VIDS, M1 Baseline)
Number of kills on OPFOR	(VIDS, M1 Baseline)
Time to kill all OPFOR	(VIDS, M1 Baseline)
Number of OPFOR killed before first hit taken	(VIDS, M1 Baseline)
Number of OPFOR before first kill taken	(VIDS, M1 Baseline)

Note. OPFOR = Opposing Forces; VIDS = Vehicle Integrated Defense System.

Table 11

List of Training Measures

Collection method	Completed by	Type of data
a. VIDS skill assessment	TCs	Recall/performance
b. Training evaluation questionnaire		
Training program evaluation	All	Rating scale
Ease of learning	TCs	Rating scale
Training time needed	TCs	Rating scale
Type of training required	TCs	Rating scale
Training items	All	Rating scale/comments
c. Structured group debrief	All	Comments

Note. VIDS = Vehicle Integrated Defense System; TCs = Tank Commanders.

SMI. Data for addressing VIDS SMI issues and design requirements were collected from four sources: (a) an SMI questionnaire administered to TCs at the completion of their group debriefing, (b) TC equipment usage as observed and reported by the RAs during scenario execution, (c) task workload assessment administered to the Plt Ldr then to all four as TCs, and (d) comments made by all participants to directed questions during their final group debriefing. Table 12 lists all the sources of data for the SMI issue. (Appendix G contains copies of the SMI and Workload Assessment questionnaires.)

Table 12

List of Soldier-Machine Interface (SMI) Measures

Collection method	Completed by	Type of data
a. SMI questionnaire		
Component/feature acceptability	TCs	Rating scale
VIDS design changes	TCs	Comments
b. Equipment usage	RAs	Point estimate
c. Workload assessment	Plt Ldrs/TCs	Rating scale
d. Structured group debrief	All	Comments

Note. VIDS = vehicle Integrated Defense System; TCs = Tank Commanders; RAs = Research Assistants; Plt Ldrs = Platoon Leaders.

TTPs. Information for identifying TTPs and issues associated with the VIDS were derived from three sources: (a) the evaluation team's Battle Master's and Co Cdr's recorded subjective ratings and comments summarized in SME questionnaires for each evaluation cycle, (b) the Plt Ldr and remaining TCs ratings and comments recorded on VIDS tactical questionnaires, and (c) all participants' comments from directed questions during their final group debriefing. Table 13 lists the three information sources used to identify TTPs and tactical issues. (Appendix G contains copies of the questionnaires.)

Table 13

List of Information Sources for Tactics, Techniques, and Procedures (TTPs)

Collection method	Completed by	Type of data
a. SME questionnaire	Armor SMEs	Rating scale/comments
b. Tactical questionnaire		
VIDS tactical performance	TCs	Rating scale/comments
VIDS tactical effectiveness	TCs	Comments
c. Structured group debrief	All	Comments

Note. SME = Subject Matter Expert; VIDS = Vehicle Integrated Defense System; TC = Tank Commander.

EXPERIMENTAL DESIGN

Figure 7 represents the partially balanced repeated measures design chosen for this evaluation. A within subjects repeated measure design was chosen to enhance statistical power to detect differences between the treatments, given the small sample size available, i.e., four platoons. Within subjects comparisons included

INDEPENDENT
VARIABLES

REPLICATION	BLOCK 1									BLOCK 2								
CONFIGURATION	B1	V1		V2		V3		V4		V1		V2		V3		V4		B2
MODE		A	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	
SCENARIO	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C
EVENT	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10	E1 to 10

Figure 7. Experimental evaluation design.

replication block, vehicle configuration, mode of operation, scenario, and engagement event. The replication block factor with two levels was chosen to allow subsequent statistical testing of learning effects from the first half to the second half of experimental trials. The configuration factor included the four VIDS configurations, (V1, V2, V3, and V4) and two baseline M1 configurations (B1 and B2) anchored at either end of the design. The operational mode factor, automatic (A) or semi-automatic (S), was not present for baseline configurations but was present in all VIDS configurations. The scenario factor included three different combat scenarios designated as A, B, or C. The event factor consisted of ten equivalent combat engagements (E1 to 10) across the scenarios.

The primary independent variable of interest was vehicle configuration. The first two research issues relate directly to configuration. The baseline M1 configuration served as the baseline for comparison. It was expected that VIDS, as a system enhancement to the M1, should theoretically demonstrate an improvement in battlefield survivability and lethality better than the standard M1 tank. Further, it was expected that each VIDS configuration should show progressive improvement in battlefield operational performance as more (or better) sensors and CMs were added to each system.

Secondary independent variables of interest were operational mode (automatic and semi-automatic), scenario, and engagement events. The operational mode variable was included to determine if battlefield operations would be affected by putting the TC in the decision cycle during implementation of CMs based on his awareness of enemy threats. Presumably, with the decrease in time afforded to the TC to react to battlefield threats, the TC may not react quickly enough to influence the survivability of his vehicle. Engagement events were discrete events linked to specific weapon platforms and weapons systems in nine of the 10 events. If the vehicle configuration had a strength or weakness against specific weapons, interactions between the type of vehicle configuration and event might reveal the effectiveness (or ineffectiveness) of those systems.

Scenario was a method for portraying the linked events as a continuous battlefield operation and provided tactical realism for the participants. Although included as a variable to be considered in the design and analysis, it was not considered important for the evaluation findings.

The replication block was added as a check for learning effects from the first half to the second half of experimental trials. Although configuration, mode, and scenario presentations were counterbalanced, it was possible that scenario learning effects would carry over into later trials as the participants began to learn events. The second baseline was included to balance the design so that an equal statistical comparison between the two blocks could be made. In the event the replication block proved significant in the analysis, they could be analyzed separately to make the primary comparisons of vehicle configuration with their

respective baseline; thus, preserving the overall effort to examine the effects of the primary and secondary independent variables.

RESULTS AND DISCUSSION

This section provides and discusses pertinent results relating to four evaluation issues presented in the Evaluation Issues section of this report. Results and discussion are followed by a brief review of evaluation limitations and a conclusive summary with recommendations.

Main effects and interactions of independent variables (Configuration, Mode, Scenario, Event, and Block) were tested using the MANOVA procedures for univariate ANOVA, with multiple comparison tests (Bonferroni t tests) conducted to detect differences between the levels of an independent variable. Significant results for the automated operational effectiveness measures (and task workload ratings in the SMI subsection) are represented by tables and graphical bar charts in the body of this section. More detailed information reporting specific statistical test results of operational effectiveness performance measures and workload ratings are summarized in tabular form in Appendix L. All significant findings were significant at least at the .05 level for main effects and their interactions and appropriately more conservative levels for the number of multiple comparisons made. Overall familywise error rate was maintained at .10 probability level. Some key non-significant performance measure data results are presented because their trends appear operationally meaningful. Key training and SMI findings and issues are descriptively portrayed in tables (or graphs) where appropriate. TTP findings and issues are primarily presented in text. Soldier and SME comments are included when appropriate.

All results associated with the VIDS configuration 2 condition were dropped from consideration for further analysis during the initial data reduction stage. During the execution of test scenarios, it was noticed that this particular configuration appeared to be extremely troublesome for the platoons during combat operations due to excessive smoke generation and frequent counterfire activations. RAs, TCs, and gunners reported frequent delays in the computer-generated images in sights and vision blocks. Additionally, more simulator and network problems appeared to occur during this condition than in other conditions. When the data were initially examined for out of range and missing values, data were frequently beyond expected ranges or were missing entirely. It was suspected that the addition of two additional long-range sensors (i.e., NIS and FASR) with no additional CMs added for protection, caused the system to continually deploy smoke and overload the network with too many moving objects. This in turn resulted in lost data or multiple data for one event (i.e., triple hits or kills for one ATGM hit on a BLUFOR element). The data contained too many missing and suspect values that could not be corrected as in the other conditions. Therefore, all reported results only pertain to the baseline condition and VIDS configurations 1, 3, and 4 conditions.

The presentation of all findings and discussion are organized by evaluation issues. The operational effectiveness subsection begins with a restatement of the two related evaluation issues, followed by the two general performance categories and the hypotheses associated with the operational performance expected for those categories, and ends with a discussion summary of the findings. The training and SMI subsection is divided into two separate sections and organized according to their primary issues and results from data collected (listed in Tables 11 and 12, respectively) during the evaluation. Summarized findings and discussion are presented with each issue. The TTP subsection is organized according to the dynamics of combat power (U.S. Department of the Army, 1993b) to systematically categorize VIDS impact on tactical operations. Armor SME opinion with appropriate soldier self-reports and debriefing comments comprise the content to address TTP findings and issues.

Combat Operational Effectiveness

This subsection addresses the impact that VIDS had on the combat operational effectiveness of the platoon as measured by survivability and lethality performance. The two evaluation issues were:

1. What is the relative combat operational effectiveness of the M1 VIDS configured vehicles in comparison to the M1 baseline system?

2. Of the VIDS configurations, which is the best configuration for optimal combat operational effectiveness?

In regard to the first issue, it was hypothesized that platoons with the VIDS-equipped M1 tanks would be more survivable and lethal during combat operations than when they used the baseline M1 tanks. The general hypothesis for the second issue was that equipping each VIDS-configured vehicle with either more (or more effective) sensors and countermeasures (CMs) would incrementally render the platoons more survivable and lethal during combat operations. Survivability performance and lethality performance findings related to these hypothesis are presented and discussed in the following paragraphs.

Survivability Performance

The measures associated with this category are divided into four survivability subcategories from threat munitions encountered in the simulated battlefield: OPFOR main gun, OPFOR ATGM, all OPFOR munitions, and BLUFOR direct fire (fratricide). Each subcategory contains a listing of the measures, associated hypothesis, findings, and discussion.

Main Gun Survivability

The five measures addressing this subcategory included: (a) number of OPFOR main gun firings at the platoon, (b) number of main gun hits sustained by the platoon, (c) number of kills sustained by the platoon, (d) average range of sustained main gun hits, and (e) average range of sustained kills. It was expected that the platoon with VIDS-equipped vehicles would receive less main gun firings and sustain less hits and kills than when using the baseline M1 tanks because: (a) their VIDS sensors would provide early warning of threats and (b) VIDS CMs would protect them from being successfully acquired and engaged. Additionally, it was expected that the average range of hits and kills sustained by the VIDS-equipped platoon would be at a closer distance than when operating with the M1 baseline. The rationale was that the VIDS sensors provide laser designation warnings allowing the platoon to attempt to avoid the engagement or allow CMs time to deploy and obscure the platoon from OPFOR acquisition. Also, OPFOR tanks would have to achieve a closer range to acquire platoon elements and penetrate the deployment cycle of the VIDS CMs to be effective. Due to the same reasons cited above, it was expected that each progressive level of VIDS configurations would decrease the number of OPFOR main gun acquisitions (as measured by firings), sustained hits and kills, and ranges of sustained hits and kills.

Table 14 contains the means, standard deviations, and statistical test results for the main effect of configuration on main gun survivability measures. The means for firings, hits taken, and kills taken were statistically significant. The configuration relationship for the first three measures, displayed in Figure 8, indicated main gun survivability was better for VIDS configurations compared to the baseline configuration. Results of the multiple comparison tests (see Table 14) indicated VIDS configurations 3 and 4, respectively, were significantly different from the baseline condition for all three measures. On the average, platoons using VIDS configurations 3 and 4, respectively: (a) received 18 and 20 less OPFOR main gun firings, (b) sustained 11and 12 less hits, and (c) sustained 7 and 8 less kills than when using the baseline M1 configuration. VIDS configuration 4 was significantly different from VIDS configuration 3 for kills taken. The remaining two measure, sustained mean hit range and mean kill range (represented in Table 14 as average meters), were not statistically testable due to the unequal distribution of missing data among configuration levels. Range distances tended to decrease for VIDS configurations (except for configuration 1 in hit range) as compared to the baseline configuration, suggesting that the OPFOR vehicles had to achieve a closer distance to effectively engage the platoons.

Main effects for Mode, Scenario, Event, and Block were not statistically significant as were most interactions. However, the Block by Configuration interaction was significant for main gun firings. Table 15

Table 14

Main Gun Survivability Performance by Configuration: Means, Standard Deviations (in parentheses), and Statistical Results

Measure	Configuration B	Configuration 1	Configuration 3	Configuration 4	F (3, 9)
Firings	21.42_a (7.76)	15.33 (12.44)	3.10_b (1.72)	1.77_b (.39)	8.04**
Hits Taken	13.85_a (7.06)	8.73 (7.29)	2.60_b (1.69)	1.54_b (.25)	6.88*
Kills Taken	7.94_a (4.43)	4.15 (3.24)	$.71_b$ (.28)	$.13_c$ (.05)	8.88**
Hit Range	1053.51 (47.15)	1166.47 (137.02)	707.03 (109.75)	969.58 (165.45)	Not Tested
Kill Range	1061.55 (62.71)	1036.50 (182.59)	635.29 (140.04)	610.39 (386.27)	Not Tested

Note. Means in the same row with different subscripts differ significantly at $p < .033$, one-tailed for the Bonferroni t test. B = Baseline.
$^*p < .05$. $^{**}p < .01$.

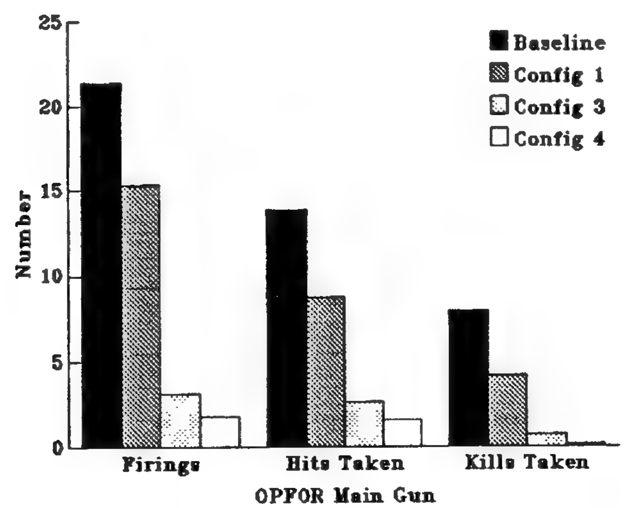

Figure 8. Platoon main gun survivability by configuration.

contains the summary means, standard deviations, and statistical test results for this interaction. The graphical relationship of this interaction is displayed in Figure 9. Block 1, which represented the first half of

Table 15

Main Gun Firings by Configuration by Block: Means and Standard Deviations (in parentheses)

Block	Configuration B	Configuration 1	Configuration 3	Configuration 4
1	39.38_a (16.70)	13.88_b (5.03)	2.17_c (1.96)	2.21_c (.21)
2	3.46 (2.08)	16.79 (22.50)	4.04 (3.98)	1.33 (.79)

Note. Means in the same row with different subscripts differ significantly at $p < .017$, one-tailed for the Bonferroni t test. B = Baseline.

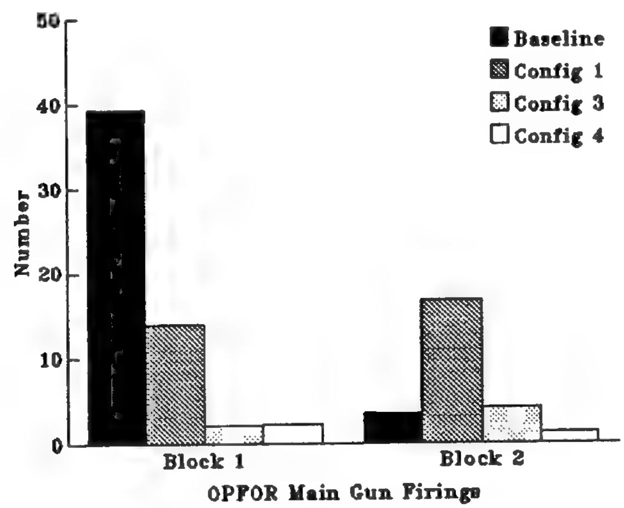

Figure 9. Configuration by block effects on OPFOR main gun firings.

experimental trials, followed the same trend as in the main effect for Configuration on kills taken and was consistent with stated expectations. Multiple comparisons tests revealed VIDS configurations 1, 3, and 4 were statistically different than baseline, and configurations 3 and 4 were statistically different from configuration 1. Block 2 revealed no statistical differences within its comparison group and did not conform to the resulting trend in Block 1. The observed tendency for decreases in numbers of main gun firings between blocks was probably due to participants learning the engagement events. In Block 2, it appeared that the baseline condition may have been dramatically influenced by platoons' prior experience with events, but it was not clear why a similar reduction was not observed in the VIDS configuration conditions.

The hypothesis that platoons using VIDS-configured tanks were less susceptible to OPFOR main gun fire as compared to when they used baseline-configured tanks was supported by the data. In general,

platoons using VIDS-configured tanks were not targeted as often by OPFOR and when engaged by OPFOR they sustained fewer hits and kills. Although the range data were not testable, the tendency was that OPFOR tanks had to come in closer to effectively engage platoons when using the VIDS configured tanks. Further, it appeared VIDS configurations 3 and 4 were the optimal VIDS configurations. Platoons using VIDS configuration 4 had significantly less catastrophic kills than the other two VIDS configurations.

ATGM Survivability

The three measures for this category were: (a) number of OPFOR ATGM firings at the platoon, (b) number of ATGM hits taken from OPFOR ATGMs, and (c) range (in meters) of sustained hits from ATGMs. Originally, ATGM sustained kills and range of ATGM kills were included as measures, but the data revealed that an ATGM hit was almost perfectly correlated with a kill; therefore, those two measures were dropped from further analysis.

VIDS configurations were progressively equipped with varying numbers of sensors and CMs for detecting weapon platforms and fired munitions (especially for ATGMs). Because of the directed effort at countering "smart" technology ATGMs, it was expected that platoons using VIDS-equipped tanks would encounter less ATGM firings, sustain less ATGM hits, and sustain ATGM hits at closer ranges than when platoons used the baseline M1 tank. Also, it was expected that as each VIDS configuration contained more sensors and CMS to defeat more of the various ATGMS, each progressive VIDS configuration would give the platoons an increased capability to survive, react, and defeat ATGM threats.

Table 16 presents the means, standard deviations, and statistical results for the main effect of configuration on ATGM survivability measures. The hit range data were not testable due to unequal distribution of missing data among the different configurations but was included as supporting similar trends as seen in the other measures. Figure 10 represents the relationship of VIDS configurations to the baseline and to each other. This figure reinforces the basic expectation that platoons operating VIDS configured tanks received less missile fire and sustained fewer missile hits than when using baseline M1 tanks.

Table 16

ATGM Survivability Performance by Configuration: Means, Standard Deviations (in parentheses), and Statistical Results

	Configuration				
Measure	B	1	3	4	F (3, 9)
Firings	9.95_a (.56)	8.35_a (1.09)	2.11_b (.17)	1.45_c (.18)	158.80***
Hits Taken	7.20_a (.79)	3.17_b (1.00)	$.25_c$ (.07)	$.11_d$ (.12)	123.81***
Hit Range	2930.47 (189.03)	2714.06 (151.04)	2836.41 (693.16)	2056.04 (1783.78)	Not Tested

Note. Means in the same row with different subscripts differ significantly at $p < .033$, one-tailed for the Bonferroni t test. ATGM = Anti-Tank Guided Missile; B = Baseline.
***$p < .001$.

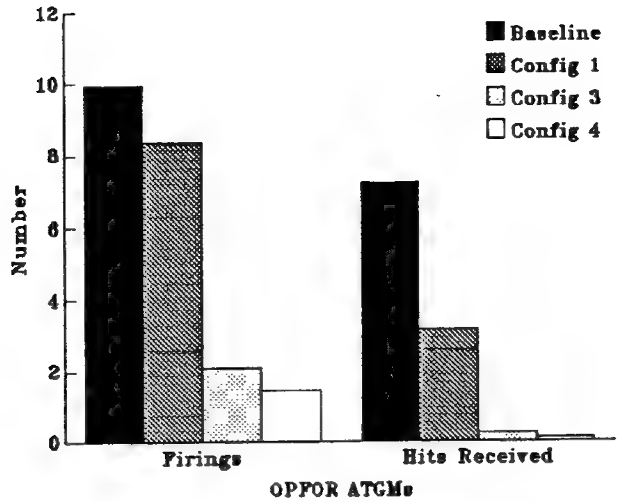

Figure 10. Platoon Anti-Tank Guided Missile (ATGM) survivability by configuration.

According to multiple comparison test results for mean number of ATGM firings (see Table 16), VIDS configurations 3 and 4 significantly differed from the baseline configuration, from configuration 1, and from each other in the expected direction. On the average, platoons using VIDS configurations 3 and 4 experienced 8 and 9 less firings, respectively, than when using baseline configured tanks. Undoubtedly, the addition of more sensors (i.e., NIS and FASR) and sophisticated CMs (i.e., CPS) available in configurations 3 and 4 added significant protection above that of configuration 1. Additionally, platoons using configuration 4 (which dropped smoke protection but added LCMD, flares, and TCS countermeasures) underwent less ATGM firings than when using configuration 3.

An examination of the means for sustained ATGM hits revealed all VIDS configurations were significantly different from baseline and from each other in the expected direction. Platoons using VIDS-configurations 1, 3, and 4 sustained 4, 7, and 7 fewer hits on the average, respectively, than when operating without VIDS in baseline M1 tanks. For VIDS-only configurations, platoons using configurations 3 and 4 sustained less hits than when using configuration 1. Further, platoons using configuration 4 sustained significantly fewer hits than when using configuration 3. Obviously, the extra CMs added per configuration enhanced ATGM survivability of platoons.

Main effects for Mode and Block and their associated interactions were not statistically significant for the ATGM survivability measures. The main effect for Scenario was significant for ATGM firings (F (2, 6) = 9.77, p = .013) and the Scenario by Event was significant for ATGM firings (F (12, 36) = 5.28, p < .001) and ATGM hits taken (F (12, 36) = 3.45, p = .002). Significant scenario differences were probably attributable to the differences between route and terrain for the presentation of the scenario engagement events. Scenario differences were not interpretable in the context of this evaluation.

Main effects for Event were significant for both ATGM firings (F (6, 18) = 71.33, p < .001) and hits taken (F (6, 18) = 18.78, p < .001). This was to be expected because each engagement event had differing numbers and weapons platforms firing different weapons at the manned platoon. Because many of the performance measures depended on mean numbers per event, these measures had significant main effects for Event. What was important for this evaluation is the effect that different configurations and operating modes had on the resulting platoon performance in the various events.

The Configuration by Event interaction was significant for ATGM firings (F (18, 54) = 10.72, p < .001) and (F (18, 54) = 9.77, p < .001). Platoons were expected to vary in performance against different weapon

systems and their ratio of attacking systems. One way to detect the difference capabilities of the VIDS was to assess the platoons' capabilities to survive and defeat certain weapon systems as they were given more protection with each VIDS configuration. Therefore, the Configuration by Event interaction was especially important in evaluating the various VIDS capabilities against various threats. It was expected that the VIDS configurations (compared to the baseline configuration) and each increasing array of VIDS configurations would give the platoons added protection against advanced technology ATGMs resulting in a decrease in ATGM firings and hits taken.

Table 17 presents the means, standard deviations, and statistical test results by configuration for the seven ATGM engagement events for ATGM firings. It was interesting to note that the first and last events, which involved short range AT-4 ATGM attacks, were not significant. The AT-4 ATGMs were often fired at very close ranges by weapon platforms. Platoons operating VIDS configurations may not have had time to detect and react to the short flight range of these ATGMs. Although not significant, there tended to be fewer launches against platoons using VIDS than when not using VIDS. In the remaining engagement events,

Table 17

ATGM Firings by Configuration by Event: Means and Standard Deviations (in parentheses)

	Configuration			
Event	B	1	3	4
Hasty attack against 2 BDRMs (AT-4)	5.13 (1.94)	3.54 (1.27)	1.75 (.35)	2.00 (1.02)
OPFOR attacks long range: 10 T-80 tanks (AT-11)	16.04 (.75) [a, -]	15.50 (4.37) [a, a]	3.75 (1.87) [b, a]	1.67 (.43) [b, b]
Air attack: 1 HIND (AT-6)	4.96 (.64) [a, -]	4.92 (1.27) [a, a]	1.25 (.50) [b, a]	1.08 (.17) [b, a]
Platoon defends, company attack: 3 T-80 tanks (AT-11)	13.29 (1.91) [a, -]	11.25 (2.95) [a, a]	2.00 (.79) [b, b]	1.33 (.24) [b, b]
Air attack: 3 HINDs (AT-6)	14.33 (3.12) [a, -]	13.96 (3.65) [a, a]	2.71 (1.06) [a, b]	1.98 (.62) [b, b]
Air attack: 2 HINDs (AT-9)	11.00 (1.25) [a, -]	8.00 (1.81) [a, a]	2.75 (.22) [b, a]	1.50 (.30) [b, b]
OPFOR ambush: 1 BDRM (AT-4)	2.42 (.69)	1.29 (.55)	.54 (.21)	.58 (.17)

Note. Means in the same row with different letters (in brackets) differ significantly at $p < .005$, one-tailed for the Bonferroni t test. First letter in brackets represents baseline to VIDS configurations comparisons and second letter represents VIDS configurations-only comparisons. Anti-Tank Guided Missile; B = Baseline.

VIDS configuration 1 was not significantly different from the baseline.

Two events were long range attacks with ATGMs fired beyond the visual range of vehicle optics (at 4000 to 6000 m): long range attacks by three T-80s using AT-11 ATGMs and two HINDs using AT-9s (laser designating missiles). Without VIDS available, the platoons were extremely susceptible to being targeted by the long distance missiles. For the ground-fired AT-11 ATGMs, platoons using VIDS configurations 3 and 4 underwent 11 and 12 less firings on the average, respectively. For the air-launched AT-9 ATGMS, platoons using VIDS configurations 3 and 4 underwent 8 and 10 less firings on the average, respectively. VIDS configurations 3 and 4's CPS countermeasure was the most likely candidate for the dramatic drop in firings. The CPS CM had a 20 degree arc that once triggered by one firing from long distance, would produce firepower kills on all the attacking OPFOR platforms, resulting in no more firings for the rest of the event.

The remaining engagement events were ones in which the ATGMs were fired right at the edge of visual range for the platoon, i.e., 3000 to 3500 m. These events included: the leading three T-80 platoon firing AT-11 ATGMs, a single HIND attack against using the AT-6 ATGM, and three HINDs attacking using AT-6 ATGMs. Platoons using VIDS configurations 3 and 4 underwent less firings on the average in all three engagements compared to the baseline configuration: 12 and 14 less for the T-80 launched AT-11s, 3 and 4 less for the single HIND launched AT-6s, and 12 and 12 less for the three HINDs attacking with AT-6s, respectively.

As shown in Table 18, a similar pattern of results was observed for ATGM hits taken in engagement events by configuration. The first and last events, the AT-4 ATGM engagements, were not significantly different. However, the general pattern of decreasing hits for VIDS configurations compared to the baseline configuration was observed. Interestingly, the first platoon (three T-80s using AT-11 ATGMs) in the company attack was not statistically significant despite the large differences between configurations 3 and 4 versus the baseline. The adjusted probability level ($p < .005$) was extremely conservative and configurations 3 and 4 were almost significant ($p = .006$). Again, the long range engagement events (i.e., long range ground attack by three T-80s with AT-11s and long range air attack by two HINDs using AT-9s) were significantly different for configurations 3 and 4 compared to the baseline. Compared to the baseline configuration, configurations 3 and 4 on the average received 13 fewer AT-11 hits and 8 fewer AT-9 hits. It was suspected that the addition of the LCMD (for decoying AT-9 missiles) and TCS (for deflecting incoming munitions) may have contributed to the significant drop in AT-9 hits taken for configuration 4 compared to configuration 3.

The remaining two engagement events were ones in which the ATGMs were fired right at the edge of visual range for the platoon. These events involved two air attacks using the AT-6 ATGM: a single HIND attack and three HINDs attacking. Platoons using VIDS configurations 3 and 4 took less hits on the average in both engagements compared to the baseline configuration: 4 for both configurations against the single HIND attack and 9 and 10 less for the three HINDs attacking.

The hypothesis that platoons using VIDS-configured tanks were less susceptible to OPFOR ATGM fires and sustained hits as compared to when they used baseline-configured tanks was supported by the data. In general, platoons using VIDS-configured tanks were not targeted as often by OPFOR and when engaged by OPFOR they sustained fewer hits. Although the range data were not testable, the tendency was that OPFOR platforms engaged platoons slightly closer when they used the VIDS-configured tanks. Further, it appeared VIDS configurations 3 and 4 were the optimal VIDS configurations. Configuration 1 was not often significantly different from baseline. Platoons using VIDS configuration 4 had significantly less ATGM firings and hits taken than the other two VIDS configurations.

Survivability From all Munitions

The only measure addressing this category was a time measure (in seconds). This measure was the time from either side opening fire until the manned platoon received its first hit. It was hypothesized that the VIDS countermeasures (such as POMALS smoke deployment or CPS optic blinding) would delay or prevent

Table 18

ATGM Hits Taken by Configuration by Event: Means and Standard Deviations (in parentheses)

Event	Configuration B	1	3	4
Hasty attack against 2 BDRMs (AT-4)	3.96 (1.51)	1.67 (.59)	.21 (.25)	.33 (.56)
OPFOR attacks long range: 3 T-80 tanks (AT-11)	13.21 (1.77) [a, -]	5.96 (1.44) [a,a]	.50 (.49) [b, b]	.21 (.42) [b, b]
Air attack: 1 HIND (AT-6)	3.50 (.56) [a, -]	2.41 (.52) [a, a]	.00 (.00) [b, b]	.00 (.00) [b, b]
Platoon defends, company attack: 10 T-80 tanks (AT-11)	10.00 (3.69)	3.88 (3.99)	.00 (.00)	.00 (.00)
Air attack: 3 HINDs (AT-6)	9.63 (2.66) [a, -]	5.08 (1.35) [a, a]	.38 (.48) [b, b]	.17 (.33) [b, c]
Air attack: 2 HINDs (AT-9)	8.42 (1.14) [a, -]	2.83 (1.76) [a, a]	.67 (.38) [b, a]	.00 (.00) [b, a]
OPFOR ambush: 1 BDRM (AT-4)	1.71 (.60)	.38 (.25)	.00 (.00)	.08 (.17)

Note. Means in the same row with different letters (in brackets) differ significantly at $p < .005$, one-tailed for the Bonferroni t test. First letter in brackets represents baseline to VIDS configurations comparisons and second letter represents VIDS-only comparisons. ATGM = Anti-Tank Guided Missile; B = Baseline.

platoons from being targeted quickly. It was also expected that the addition of countermeasures to each successive VIDS configuration would result in progressively extended time delays before receiving a hit.

Table 19 presents the means, standard deviations, and statistical test results for the main effect of configuration on time to first hit taken. Figure 11 illustrates the main effect of configuration on this measure. Although the relationship appeared to support the hypothesis that the platoons using the VIDS-equipped tanks sustained their first hit later than when operating the baseline configuration, only configuration 3 was significantly different from baseline. Interestingly, configuration 4 was significantly different from configuration 1. An examination of the standard deviations revealed that platoon performance in the baseline configuration was quite varied and tended to overlap performance associated with both configurations 1 and 4. Configuration 3, having both POMALS and CPS, undoubtedly had the greater advantage in preventing enemy acquisition.

The main effect for Scenario (F (2, 6) = 7.12, p < .05), main effect for Event (F (7, 21) = 18.08, p <

Table 19

Time to First Hit Taken (in seconds) for All Munitions by Configuration: Means, Standard Deviations (in parentheses), and Statistical Results

Measure	Configuration B	Configuration 1	Configuration 3	Configuration 4	F (3, 9)
Time to first hit taken	75.40 (59.75) [a, -]	101.69 (24.54) [a, a]	176.44 (17.21) [b, b]	163.80 (14.23) [a, b]	8.51**

Note. Means in the same row with different letters (in brackets) differ significantly at $p < .033$, one-tailed for the Bonferroni t test. First letter represents baseline to VIDS configuration comparisons and second letter represents VIDS configurations-only comparisons. B = Baseline.
**$p < .05$.

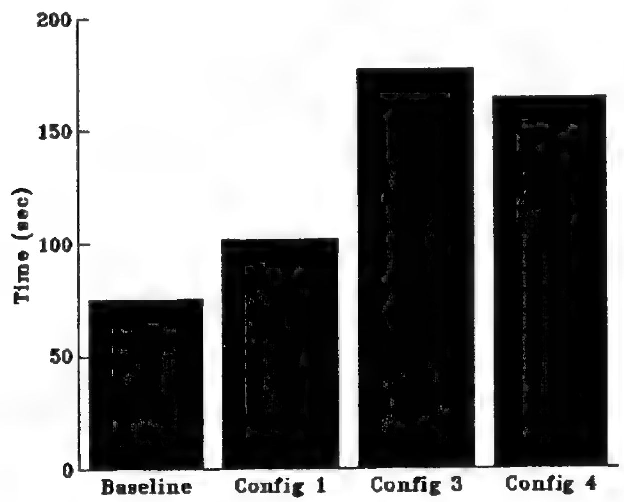

Figure 11. Main effect of configuration on opening to first hit time.

.001), and Scenario by Event interaction (F (12, 36) = 4.35, $p < .001$) were significant. The reasons for these differences were explained previously in the ATGM survivability discussion. As mentioned before, significant Scenario differences were probably due to differences in terrain and route presentation of events. Significant Event differences were expected due to varying numbers and kinds of threats presented per event.

The main effects for Block and Mode as well as most of their interactions were not significant. The significant triple interaction, Configuration by Mode by Event (F (14, 42 = 2.43, $p < .05$), was interesting, but was not interpretable given that there was no statistical power to detect differences among the various configurations and modes within the events. (All triple interactions were not testable given the sample size in this evaluation.)

The only remaining significant interaction for this measure was Configuration by Event. Table 20 presents the means, standard deviations, and the multiple comparison results for all the events for this measure. Generally, across all events there appeared to be a tendency for VIDS configurations, in comparison to the baseline configuration, to have longer elapsed times before receiving their first hit. However, only three events had significant configuration differences: air attacks from a single HIND or three HINDs using AT-6 ATGMs and a long range air attack from two HINDs using AT-9 ATGMs. For the single HIND attack, configuration 3 was on average 150 sec longer than the baseline configuration and was significantly different from configurations 1 and 4. Configurations 1 and 4, although exhibiting large differences from baseline with relatively small variations, were not significantly different due to the stringent

Table 20

Time to First Hit Taken (in seconds) for All Munitions by Configuration by Event: Means and Standard Deviations (in parentheses)

	Configuration			
Event	B	1	3	4
Hasty attack against 2 BDRMs (AT-4)	38.67 (24.04)	53.50 (6.70)	142.25 (27.23)	114.29 (19.12)
Meeting engagement: 3 T-80s (main gun)	46.33 (48.51)	43.46 (66.59)	45.96 (22.19)	30.00 29.37)
OPFOR attacks long range: 3 T-80 tanks (AT-11)	134.96 (22.20)	154.46 (37.12)	252.33 (62.21)	218.42 (64.15)
Air attack: 1 HIND (AT-6)	8.13 (4.68) [a, -]	36.92 (12.09) [a, a]	111.67 (22.60) [b, b]	114.58 (44.30) [b, a]
Platoon defends, company attack: 10 T-80s (AT-11 and main gun)	111.13 (126.46)	264.33 (117.28)	459.00 (61.07)	419.42 (74.97)
Air attack: 3 HINDs (AT-6)	32.00 (6.62) [a, -]	95.33 (35.71) [a, a]	152.38 (33.35) [b, b]	182.07 (50.15) [b, b]
Air attack: 2 HINDs (AT-9)	18.88 (5.44) [a, -]	83.33 (44.98) [a, a]	169.17 (49.68) [a, a]	145.75 (43.29) [b, a]
OPFOR ambush: 1 BDRM (AT-4)	213.08 (314.81)	82.21 (40.22)	78.13 (46.94)	83.58 (50.89)

Note. Means in the same row with different letters (in brackets) differ significantly at $p < .004$, one-tailed for the Bonferroni t test. First letter in brackets represents baseline to VIDS configurations-only comparisons and second letter represents VIDS configurations-only comparisons. B = Baseline.

probability level (p = .004) associated with the multiple comparison testing. In comparison to using the baseline configuration, platoons using configurations 3 and 4 in the three HIND air attack event, had significantly longer delays from opening to first hit: approximately 120 and 150 sec longer, respectively. The long range attack from two HINDs with AT-9 ATGMs was started beyond the possible visual capability of the platoon. In comparison to when the platoon used the baseline configured tanks, the platoons using tanks in configuration 4 had an elapsed delay in opening to hit time that was on average 127 sec longer.

In summary, there was evidence to support the general hypothesis that VIDS delayed the onset of a first hit once the engagements started. Configuration 3 appeared to have an advantage in delaying timely enemy acquisition and successful engagements. This was due, in all probability, to the smoke obscuration capability versus just the CPS. The combination of smoke generating capability and the capability to blind optical sights was particularly effective against HINDs using AT-6 ATGMs. Configuration 4 was particularly effective against HINDs using the AT-9 ATGMs.

Fratricide Survivability

Four of the six raw frequency measures addressing this category were: (a) number of friendly lases to friendlies, (b) number of friendly firings on friendlies, (c) number of friendly hits on friendlies, (d) number of friendly catastrophic kills on friendlies. Two measures, number of friendly CPS firings on friendlies and number of CPS "kills"on friendlies, were only for VIDS configurations 3 and 4. It was expected that VIDS would assist the Plt Ldrs and TCs in maintaining awareness of the battlefield via their extra sensors. Also, it was expected that fratricide would be an extremely rare event for any of the configurations, but even more rare for configurations 3 and 4 because of the addition of active radar (FASR) which could sense and paint moving platforms on the CCDP in relation to own vehicle. Table 21 presents the raw frequency of all fratricide events by configuration.

Table 21

Frequency Distribution of Fratricide Survivability Measures

	Configuration			
Measure	B	I	3	4
Lases	38	36	25	36
Firings	15	22	9	18
Hits	1	2	8	14
Kills	1	1	1	2
CPS Firings	N/A	N/A	7	11
CPS Kills	N/A	N/A	0	1

Note. Frequency data is based on 960 trials. B = Baseline; CPS = Combat Protection System.

As can be seen, there was not a discernable linear tendency for fratricide lases and firings. Fratricide lases may have included lases of platoon vehicles to other platoon vehicles for purposes other than

acquisition. Some soldiers reported that they lased to other platoon elements to establish their positions during maneuver and defensive setup in field exercises, and especially in simulation training exercises. It was difficult for platoon elements to establish distance from a two-dimensional view presented in sights and vision blocks. Therefore, the fratricide lasing data were most likely contaminated with how soldiers used friendly lasing in the simulation environment.

The fratricide firings data was suspect to some extent due to the way the measure was defined and extracted. Firings directed against other platoon elements were collected when one element fired within the minimum range and azimuth of another platoon element. It would have included any firings over the top of another element such as when the platoon was in a defensive position on hills. Despite this possibility, the numbers appeared to be representative of fratricide firings, especially when configuration 3 and 4 firings were compared to the actual fratricide hits. It was possible the number of firings decreased from VIDS configuration 1 to 3 because of the FASR, which would have aided the TCs in knowing where there other elements were located. The rise in firings in configuration 4 may have been due to the additional sensor (MFD) which automatically activated counterfire, slewing the main gun tube to the direction of friendlies that fired their main gun. TCs and gunners frequently complained to the RAs and during debriefings about this phenomena.

The corresponding increase in fratricide hits with each progressive VIDS configuration was a disturbing tendency. Counter to expectations, the frequency of hits increased per additional configuration. SMEs and the Evaluation Director observed that smoke deployment accounted for some of the fratricide hits in configurations 1 and 3, especially in close combat with T-80 tanks. Another possible problem was that the automatic counterfire activations increased with added sensors. As mentioned before, TCs and gunners reported problems with the automatic counterfire slewing their gun tubes onto other platoon elements. The problem was compounded when sight pictures were degraded or were running behind real time due to multiple smoke deployments. For configuration 4, smoke was not the problem, but the MFD may have been. TCs and gunners reported that when one of the platoon elements fired in a nearby position, their gun tube would automatically slew to that tank. When this occurred during engagements, the results were near misses and sometimes hits. Corresponding fratricide kill data did not reveal similar configuration patterns like the firings and hit data.

For configurations 3 and 4, the CPS countermeasure was of particular concern. The CPS would activate automatically in a 270 degree arc against perceived threats, as defined by the TRMs interpretation of incoming sensory information. CPS would direct a beam within a 20 degree arc for three seconds toward the perceived threat. To receive a firepower kill from a CPS emission, vehicle sights and vision blocks would have to be oriented directly toward the beam. It was expected that there might be some firepower fratricide from this automated CM because there was no override control planned for this evaluation.

Possibly, the number of CPS firings at friendlies was not all due to fratricide. Any of the platoon vehicles may have been in the path of a CPS beam aimed at a threat. The 20 degree cone could have encompassed a platoon element, especially during maneuver. However, the slight increase of firings from configuration 3 to 4 indicated some degree of fratricide engagement. Possibly, the combination of the same sensors as in configuration 3, with the extra MFD sensor available to configuration 4, may have accounted for the slight increase. The only CPS kill occurred in configuration 4.

Summarily, the fratricide data, although not statistically significant, was practically significant. The data appeared to run counter to expectations. The simulation system itself may have contributed to fratricide occurrences when the computer imagery did not maintain real-time portrayal of battlefield events during gunnery engagements. However, not all fratricide events could be attributed to simulation failures. Extra sensory capacity may have actually contributed to fratricide events as seen in the linear increase in fratricide hit and CPS firings data. Having heightened battlefield awareness from extra sensors may not help when automated defense system CMs cannot be over-ridden by the operator.

Summary of Survivability Performance Findings

Table 22 presents a summary of the findings associated with survivability performance. The hypothesis that platoons using VIDS-equipped tanks would be less susceptible to main gun and ATGM fire was confirmed. Also, the expected progressive incidence of survivability of each VIDS configuration was demonstrated. VIDS equipped platoons, especially when operating in configuration 3 or 4, were targeted less often by enemy tanks and helicopters and sustained fewer hits and kills from the enemy munitions. Although range data were not statistically testable, trends appeared to indicate enemy vehicles and aircraft needed to achieve a closer range to be effective in engaging VIDS-equipped platoons. Once an engagement started, VIDS-equipped platoons (using configurations 3 and 4) had more time to conduct tactical operations before sustaining their first hit. However, counter to expectations, VIDS-equipped platoons generally had increasingly more instances of fratricide associated with each successive configuration.

Table 22

Summary of Survivability Performance Findings

Measure category	Findings for VIDS configurations
Main gun survivability	- Significant reduction in the frequency of enemy acquisition and engagements, sustained hits, and sustained kills
	- Reduction in enemy stand-off range for effective engagements
ATGM survivability	- Significant reduction in the frequency of enemy acquisition and engagements and in sustained hits
	- Reduction in the ATGM stand-off range for effective enemy engagements
	- Significant reduction in frequency of enemy acquisition and engagements and sustained hits for long range ground-launched (AT-11s) and air-launched (AT-6 and AT-9) ATGMs
	- Reduction in frequency of enemy acquisition and engagements and sustained hits for short range ground-launched (AT-4s) ATGMs
All munitions survivability	- Significantly increased survival times from engagement openings to first hit received
Fratricide survivability	- Increased risk of fratricide engagements and hits

Note. AT = Anti-Tank; ATGM = Anti-Tank Guided Missile.

Configurations 3 and 4 were significantly more effective than configuration 1 in all survivability performance. Configuration 4 was more effective than configuration 3 in all but one measure, time to first hit for all munitions. Based on these findings, configuration 4 was the optimal configuration in survivability performance.

Noticeably, Mode was not a significant factor in any of the survivability performance. This was probably attributable to the way operational mode was implemented. Semi-automatic mode essentially became

automatic once the CCH VIDS activation button was pushed. The threat queue may have never cleared between engagements, resulting in continuing automatic VIDS operation. Future designs for implementing operational mode should provide for clear distinctions between modes in order to test its effects.

Lethality Performance

The measures associated with this category were divided into two subcategories: (a) detection and (b) acquisition and engagement. The two subcategories were related to two critical aspects of gunnery. With the addition of VIDS, it was generally expected that there would be improvements in detection of and effective engagement with enemy platforms. Each subcategory contains a brief description of the measures, associated hypotheses, findings, and discussion. Generally, it was expected that (a) VIDS sensors would allow platoons to rapidly detect, locate, and acquire enemy platforms and (b) VIDS countermeasures would deny the enemy the opportunity to make effective use of their weapons systems while the platoon massed fires and/or closed quickly to destroy the enemy.

Detection

The three measures addressing this subcategory included: (a) time (in seconds) for first contact per event, (b) time (in seconds) from first contact to first round fired at the enemy, and (c) range (in meters) of the first platoon element lase to an enemy weapon platform. It was hypothesized that platoons operating in VIDS-equipped vehicles would be able to use their sensors and CCDP displayed icon locations to detect and orient rapidly to enemy weapon platforms than when operating without the benefits of VIDS in a baseline configuration. Also, it was expected that as progressively more sensors were added to each configuration, a corresponding decrease in time would occur for first contacts and contact to rounds fired. It was expected that the range of first lase to the enemy would increase as location and direction of enemy platforms became known (especially when FASR and NIS sensors were added).

Table 23 presents the means, standard deviations, and statistical test results for the main effect of configuration on detection measures. None of the VIDS configuration means were statistically different from their corresponding baseline configuration mean. Although an overall significant difference was found for the last measure (range of first lase), the statistical finding was attributable to the difference between configuration 3 and 4. Neither were statistically differentiated from the baseline mean.

Although not statistically different, the tendency for time of first contact (per event) was lower for VIDS configurations than baseline. VIDS configurations 3 and 4 appeared almost half as low as VIDS configuration 1. The NIS sensor available to configurations 3 and 4 allowed platoons to sense helicopter threats long before they were visible and before events started for helicopter threats. However, when platoons made contact before the helicopter event, time was recorded as zero for that event instead of a negative number. Thus, there was a floor effect on the data. Results for configurations 3 and 4 would most likely have been dramatically lower.

Contact to first round time data appeared counter to what was expected, especially for the higher VIDS configurations. The tendency for configurations 3 and 4 to exhibit delayed times for the contact to first round measure was easily explained. Onset of contact with the enemy, especially HINDs detected with NIS and ground vehicles detected with FASR, was much sooner in the event before visual contact could be made for acquisition and engagement. Thus, the longer times observed for configurations 3 and 4 was attributable to the quicker contact times.

Although the main effect of configuration was significant, range of first lase data were not differentiated from baseline. It was possible that platoons waited until enemy vehicles were much closer before making their first acquisition. TCs and gunners complained frequently about the inaccuracy of the simulated fire control at long distances (beyond 2000 m). Platoons learned quickly that there were decreasing probabilities for successful long range shots and displayed reluctance in acquiring and engaging at long range.

Table 23

Detection Performance by Configuration: Means, Standard Deviations (in parentheses), and Statistical Results

Measure	Configuration B	Configuration 1	Configuration 3	Configuration 4	F (3, 9)
Time to first contact	217.45 (47.02)	200.72 (53.02)	108.86 (47.18)	116.64 (45.48)	4.45
Contact to first round time	40.98 (28.66)	20.32 (5.76)	81.92 (39.86)	71.22 (49.31)	5.02
Range of first lase	2515.10 (97.90)	2556.41 (101.69)	2443.70 (98.93)	2517.30 (122.69)	8.80**

Note. B = Baseline.
**p < .01.

Mode and Block main effects were not significant for these three detection measures. One significant Scenario main effect was observed for range of first lase data (F (2, 6) = 21.33, p = .002). Significant Event main effects were observed for all three measures: time to first contact (F (9, 27) = 7.72, p < .001), contact to first round time (F (9, 27) = 6.95, p < .001), and range of first lase (F (9, 27) = 75.70, p < .001). Significant Scenario by Event interactions were also observed for scenario by event interactions for the same three measures: time to first contact (F (18, 54) = 4.36, p < .001), contact to first round time (F (18, 54) = 3.11, p < .01), and range of first lase (F (18, 54) = 10.29, p < .001). Scenario main and Scenario by Event interaction effects were not interpretable given the varied presentation of terrain in each scenario. Event effects were expected since engagement events offered varying amounts and kinds of threat presentations. The Configuration by Event interaction was not capable of being statistically evaluated due to computation limitations associated with the MANOVA repeated measures procedure. Three-way and higher order interactions were not capable of being statistically compared and were dropped from further analysis.

In summary, the hypotheses that VIDS configurations would allow platoons to achieve better detection performance than when using the baseline configuration was not proven. It was noteworthy that in the data for first contact times there was an observed trend for quicker contact for VIDS configurations, especially configurations 3 and 4. The limitation of the data to zero and above per event restricted the range of true effects for contact times for VIDS configurations 3 and 4 which contained NIS and FASR sensors. The increased times observed for configurations 3 and 4 in contact to first round times was attributable to quicker contact times before visual acquisition was possible for the platoons. It would appear that detection and acquisition, as measured by range of first lase, was restricted to an upper zone limit (around 2500 m) where platoons were engaging enemy platforms in the simulated battlefield. Possibly, platoons believed from their gunnery experience in the simulation that this was the maximum limit for making effective acquisitions and successful engagements.

Acquisition and Engagement

There were six measures for this category: (a) manned hits per round, (b) mean platoon catastrophic kills on OPFOR, (c) time required to kill all OPFOR, (d) mean range of OPFOR kills, (e) number of

OPFOR killed before first platoon element hit, and (f) number of OPFOR killed before first platoon element killed. The last two measures were effectiveness measures illustrating the direct link survival time would have on lethality performance. It was expected that the VIDS-equipped platoons would use their advanced sensors to efficiently mass fires to effectively destroy the enemy in less time and at longer ranges and use the hit-avoidance advantage of their countermeasures to destroy more enemy before sustaining a hit or kill.

Table 24 presents the means, standard deviations, and statistical results for the main effect of Configuration on the acquisition and engagement performance measures. An examination of the tabled data revealed no main effect for two efficiency measures, the hits per round measure and time to kill all OPFOR measure. No discernable trend was apparent for the hits per round measure, but the time to kill all OPFOR measure data appeared to be consistent with progressively improved efficiency for VIDS configurations in relation to baseline and to each other. The mean range for OPFOR kills data were not testable due to unequal distribution of missing data among the different configurations. Range data were unequally distributed with more trials (events) represented in the baseline and VIDS configuration 1 than in VIDS configurations 3 and 4.

Table 24

Acquisition and Engagement Performance by Configuration: Means, Standard Deviations (in parentheses), and Statistical Results

Measure	Configuration B	1	3	4	F (3, 9)
Hits per round	.46 (.05)	.44 (.05)	.39 (.04)	.42 (.02)	3.43
Catastrophic kills	2.97 (.09)	3.03 (.11)	2.59 (.09)	2.56 (.24)	19.48***
Time to kill all OPFOR (seconds)	76.23 (9.56)	69.50 (7.96)	67.50 (14.20)	63.92 (2.80)	1.52
Range of kills (meters)	1937.98 (102.77)	1959.87 (81.14)	2084.93 (205.83)	2186.39 (381.02)	Not Tested
Kills before first hit taken	1.17_a (.24)	1.83_b (.25)	1.71_b (.24)	1.45_b (.25)	16.42***
Kills before first kill taken	1.22_a (.26)	1.99_b (.15)	1.79_b (.25)	1.61_b (.18)	22.83***

Note. Means in the same row with different subscripts differ significantly at $p < .033$, one-tailed for the Bonferroni t test. B = Baseline; OPFOR = Opposing Forces.
***$p < .001$.

Although the main effect of configuration was significant for the mean number of catastrophic kills, multiple comparison tests revealed no significant differences for any of the possible pairs of data. It was

expected configurations 3 and 4, with more sensors and more countermeasures, would have the higher number of catastrophic kills. The data appeared contrary to expectations in that configuration 1 and baseline were higher than configurations 3 and 4. It was possible the automated counterfire was problematic for configurations 3 and 4 compared to configuration 1. RA observations and soldier (TCs and gunners) comments often were made about automated counterfire designating to non-targets (i.e., burning tanks or yet-to-be-visible helicopters) and to each other, especially when trying to acquire enemy targets of interest. When this happened, enemy platforms either travelled behind terrain or flew out of sight prior to the end of the engagement event leaving the platoon without the maximum number for kills available for that event. An alternative explanation was that CPS "killed" enemy targets at very long ranges and the platoons never detected the targets visually to destroy them.

Configuration by Event interactions were significant for both the number of catastrophic kills measure (F (27, 81) = 14.84, p < .001) and time to kill all OPFOR measure (F (27, 81) = 2.12, p = .005). However, multiple comparison tests revealed no paired comparison differences for different events for the number of catastrophic kills data. Only one event difference for the time to kill all OPFOR measure was significant; the meeting engagement with three T-80 tanks. The only paired significant difference (p < .003) was between the baseline configuration (M = 28.46, SD = 6.44) and configuration 4 (M = 12.44, SD = 4.14). This one comparison difference, given the large number of possible non-significant comparisons, was possibly spurious and provided no meaningful insights.

The Configuration by Mode interaction effect for the number of catastrophic kills measure was significant (F (2, 6) = 9.07, p < .05). However, multiple comparison tests revealed no significant differences between any pairs of means in either mode. No differences were expected between operational modes because semi-automatic mode was essentially in automatic mode once it was activated by the TC.

No main effects for Block, Scenario, or Mode were observed for any of the first three testable measures. Significant Scenario by Event interactions were observed for manned hits per round (F (18, 54) = 4.21, p < .001), number of catastrophic kills (F (18, 54) = 5.85, p < .001), and time to kill all OPFOR (F (18, 54) = 3.96, p < .001) measures. However, none of these interactions were of interest to this evaluation, given scenario differences were inexplicable and event differences were expected based on the numerically differing weapons platforms between events.

The relationships between configuration means for the remaining two performance measures, number of OPFOR kills before first platoon hit and number of OPFOR kills before first platoon kill taken, are depicted in Figure 12. As can be seen in Table 24, VIDS configurations were significantly different than the baseline configurations in the expected direction for both measures. The expectation that progressively better performance would be observed in each successive VIDS configuration was not confirmed for either measure. Platoons, while operating configurations 1, 3, and 4, were more effective in destroying the enemy before receiving their first platoon hit or kill than when operating in the baseline configuration. There were no statistical differences between configurations 1, 3, and 4 for either measure. Although VIDS configurations were not statistically different from each other, it was interesting to note that when platoons used configuration 1 they achieved slightly more kills than when using configuration 3 or 4 and when they used configuration 3 they achieved slightly more kills than when using configuration 4. Overall, the results suggested VIDS (in any configuration) improved battlefield lethality by allowing the VIDS-equipped platoons to survive longer on the battlefield to achieve more kills. The data for VIDS configurations only, did not provide support that increasingly adding more sensors and countermeasures confer improved lethality. Possibly, automated counterfire problems, as previously mentioned in this report, offset any improved lethality gained through longer survivability.

The Configuration by Event interaction for number of OPFOR kills before first hit taken was significant (F (21, 63) = 4.51, p < .001). Table 25 presents the means, standard deviations, and multiple comparison results for the three (of eight possible) events containing statistically different paired comparisons: platoon hasty attack against two BRDMs (armed with AT-4 ATGMs), air attack by one HIND (armed with AT-6 ATGMs), and hasty defense against OPFOR company attack (nine T-80s with AT-11 ATGMs and 125mm

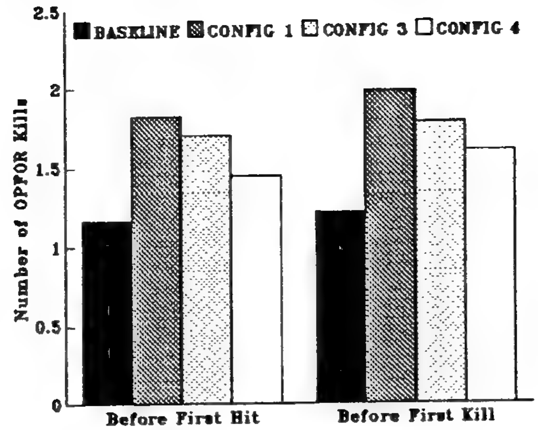

Figure 12. Configuration effects on number of OPFOR kills before receiving first platoon hit or kill.

Table 25

Number of OPFOR Kills Before First Hit Taken by Configuration by Event: Means and Standard Deviations (in parentheses)

	Configuration			
Event	B	1	3	4
Hasty attack against 2 BDRMs (AT-4)	1.21_a (.28)	1.54 (.34)	1.75 (.29)	1.77_b (.34)
Air attack: 1 HIND (AT-6)	$.46_a$ (.21)	$.75_b$ (.29)	.58 (.10)	.50 (.24)
Platoon defends, company attack: 9 T-80s (AT-11 and main gun)	3.21_a (1.30)	5.96 (1.42)	6.08_b (.63)	4.83 (1.34)

Note. Means in the same row with different letters differ significantly at $p < .004$, one-tailed for the Bonferroni t test. B = Baseline; BDRMs = Armored Reconnaissance Wheeled Vehicle; HIND = Attack Helicopter; AT = Anti-Tank; T-80 = Main Battle Tank.

main gun rounds). For the platoons attack against the two BDRMs, the platoon was more effective at killing BRDMS using configuration 4 than when using the baseline configuration. Configurations 1 and 3 were not statistically different from baseline. For the single HIND air attack, platoons using configuration 1 were more effective at killing the HIND than when using the baseline configuration. Configurations 3 and 4 were not statistically different from baseline. For the company attack, platoons using configuration 3 were more effective at killing the nine T-80 tanks than when using the baseline configuration. Configurations 1 and 4 were not statistically different from the baseline. The non-significant results in the other five events revealed no supporting trends for any particular configuration advantage.

The Configuration by Event interaction for number of OPFOR kills before first kill taken was significant (F (21, 63) = 8.78, p < .001). Table 26 presents the means, standard deviations, and multiple comparison results for the three (of eight possible) events containing statistically different paired comparisons: platoon hasty attack against 2 BRDMs (armed with AT-4 ATGMs), air attack by one HIND (armed with AT-6 ATGMs), and air attack by two HINDs (armed with AT-9 ATGMs). For the platoons attack against the two BDRMs, the platoon was more effective at killing BRDMS using configuration 4 than when using the baseline configuration. Configurations 1 and 3 were not statistically different from baseline. For the single HIND air attack, platoons using configuration 1 were more effective at killing the HIND than when using the baseline configuration. Configurations 3 and 4 were not statistically different from baseline. For the air attack of two HINDs, platoons using configuration 4 were 159% more effective at killing the two HINDs than when using the baseline configuration. Configurations 1 and 3 were not statistically different from the baseline. The non-significant results in the other five events revealed no supporting trends for any particular configuration advantage.

Table 26

Number of OPFOR Kills Before First Kill Taken by Configuration by Event: Means and Standard Deviations (in parentheses)

	Configuration			
Event	B	1	3	4
Hasty attack against 2 BDRMs (AT-4)	1.21_a (.28)	1.54 (.34)	1.79 (.25)	1.88_b (.16)
Air attack: 1 HIND (AT-6)	$.46_a$ (.21)	$.75_b$ (.29)	.58 (.10)	.50 (.24)
Air attack: 2 HINDs (AT-9)	$.63_a$ (.34)	1.46 (.16)	.92 (.40)	1.00_b (.27)

Note. Means in the same row with different letters differ significantly at p < .004, one-tailed for the Bonferroni t test. B = Baseline; BDRMs = Armored Reconnaissance Wheeled Vehicle; HIND = Attack Helicopter; AT = Anti-Tank.

In summary, acquisition and engagement results were mixed in their support for hypothesized expectations. No discernable trend was observed for the manned hits per round data. The number of catastrophic kills measure, although significant, had no paired comparisons indicating differentiation between the configurations. The time to kill all OPFOR data were not statistically significant. The mean range of kills data were not statistically testable due to unequal distribution of the range data among the configurations. The data from number of OPFOR kills before first hit taken and number of OPFOR kills before first kill taken were statistically significant and followed identical patterns for the main effect of Configuration.

Given the hypothesis that VIDS configurations should have given the platoon the capability to be more efficient and effective in their rounds per hit and catastrophic kills inflicted on the OPFOR, the data did not support the hypothesized expectations. It was thought, given RA observations and soldier feedback, that the automated counterfire problems experienced in VIDS configurations, especially configurations 3 and 4, countered any enhanced acquisition and engagement benefits attributable to the VIDS. The exhibited trends in the time to kill all OPFOR data and the mean range of kill data provided tenuous (but no statistical)

support for the progressive advantage of VIDS configurations over that of the baseline configurations. The similar results exhibited for both OPFOR kills before receiving a hit and OPFOR kills before receiving a kill provide strong support for the increased engagement effectiveness for platoons using VIDS versus the baseline configuration. However, the trend for progressive effectiveness was not evident. Configurations 1, 3, and 4 were not statistically different from each other. Possibly, given the TCs and gunners comments, the progressive advantages of increased protection by VIDS countermeasures in each successive configuration were more than offset by an increased inability to kill because of increasing problems with automated counterfire.

Summary of Lethality Performance Findings

Table 27 presents the summary of findings associated with lethality performance. The hypothesis that platoons using VIDS-equipped tanks would be more lethal was not statistically confirmed by the detection data and only partially statistically confirmed by the acquisition and engagement effectiveness data. Additionally, there was no statistical confirmation of the progressive effectiveness in lethality for each successive VIDS configuration. There was a noted tendency for contact times to be quicker for each successive VIDS configuration indicating that the enhanced sensor arrays (especially NIS and FASR) conferred some advantage for early detection. In acquisition and engagement data, there was a trend for progressively faster kill rates and extended kill ranges associated with each successive VIDS configuration. Possibly, these early detection, acquisition, and engagement trends indicated the VIDS allowed platoons to rapidly locate the enemy, acquire and engage effectively and at longer distances, thus accelerating the tempo and successful outcome of the battle. However, there were no noted trends confirming the progressive improvement in each successive VIDS configurations on acquisition and engagement effectiveness. Notably, the data from OPFOR kills before receiving first hits or kills did not confirm this expectation. Platoons using each successive VIDS configuration did not become more effective in destroying the OPFOR. Noted complaints from TCs and gunners (and independent observations from RAs) indicate that automated counterfire was increasingly problematic for each successive VIDS configurations. Even though early warnings of enemy were available and increasingly more protection was afforded to each configuration, the automated counterfire was increasingly more problematic, preventing effective engagements.

Table 27

Summary of Lethality Performance Findings

Measure category	Findings for VIDS configurations
Detection	- Reduction in the time to report enemy contacts
Acquisition and engagement	- Slight decrease in time to kill all detected enemy weapon systems
	- Slightly extended ranges for enemy kills
	- Significantly improved effectiveness to destroy the enemy before receiving the first hit or kill

Note. VIDS = Vehicle Integrated Defense System.

No configuration was statistically more effective than other VIDS configurations in lethality performance. There were some trends indicating successive improvements for each successive configuration for one of the three detection measures and two of the six acquisition and performance measures. However, inverse tendencies were noted for the only statistically significant measures. Therefore, no optimal VIDS

configuration can be recommended for improving lethality performance.

As noted in the findings for survivability performance, Mode was not a statistical influence. The noticeable lack of Mode effects in the lethality performance data confirmed the failure to implement operational mode effectively for this experimental evaluation.

Training and Soldier Machine Interface (SMI) Implications

This section addresses the key findings associated with the third evaluation issue:

What are the relevant training and SMI issues and requirements for the future VIDS system?

The results of the data analysis related to training and SMI issues gathered during the VIDS evaluation are presented in this section. Training and SMI results are sub-divided into two subsections. Each subsection is organized around key sub-issues with related findings and discussion followed by a brief summary.

<u>Training</u>

This subsection is adapted and organized according to five training-related sub-issues (as found in Atwood et al, 1991) that address the training component of the evaluation. The five sub-issues, in the form of answerable questions, were:

(a) How adequate were the training materials and procedures used to prepare the soldier participants to use the equipment?

(b) How sufficient was the amount of time devoted to training the specific functions of the equipment?

(c) How easy was it to learn to use the equipment?

(d) What would be the training requirements (type and length of training) to prepare tankers to use this type of equipment if it were fielded?

(e) What are the soldier participant comments for improving the training?

<u>Sub-issue a: How Adequate Were the Training Materials and Procedures Used to Prepare the Soldier Participants to Use the Equipment?</u>

This issue was addressed by examining two categories of data: sections from the training evaluation questionnaire data gathered from soldier-participants and performance data derived from the VIDS Skill Test. Questionnaire data were used to assess reactions to the adequacy of the training program and TC skills test performance was used to gauge the effectiveness of the program to use the equipment after participating in the program. The results from the two categories of data are presented below.

<u>Training evaluation.</u> Training evaluation questionnaires were administered to the TCs, gunners, and drivers after the offensive STX debrief. Because most of the training program was oriented toward training VIDS operation tasks, the most detailed data were collected from the TCs. More limited evaluations were collected from the gunners and drivers.

Table 28 provides a summary of the TCs' evaluation of the training program's adequacy. The table presents the question and their views on classroom training, demonstrations, hands-on simulator training and hands-on VIDS training. The first column gives the mean and the second column provides the associated standard deviation with each program component. An examination of the tabled data revealed all averaged ratings were above the midpoint of the scale, which indicated that the TCs had a favorable view of the training provided. Generally, hands-on training was rated slightly higher than the classroom and

Table 28

Tank Commander Evaluations of Training on Equipment Operations

How would you rate the components of the training program in preparing you to operate the VIDS?	M	SD
Classroom training		
Classroom sessions-overall	3.50	0.63
Instructor's presentation	3.63	0.72
Viewgraphs	3.63	0.50
Handouts	3.69	0.60
Examples of tactical equipment use	3.50	0.73
VIDS demonstration		
VIDS model demonstration	3.38	0.81
Large screen instruction	3.44	0.73
Hands-on simulator training		
Hands-on training	3.88	0.62
RA explanations	4.06	0.57
Hands-on VIDS training		
Hands-on training	3.88	0.72
Skills test	3.69	0.60

Note. N = 16. Ratings were made on a 5-point scale where 1 = Poor and 5 = Excellent. VIDS = Vehicle Integrated Defense System.

demonstration components. Soldier comments to these items revealed that they favored more hands-on training to classroom instruction.

Table 29 displays the TCs evaluations of the of the tactical exercises used during the training program. The VIDS hands-on training included individual brief tactical confrontations with enemy platforms whereas crew and platoon training involved the whole crew and platoon as an integrated effort against enemy platforms. Although the overall ratings indicated the TCs were generally positive toward all tactical training exercises, there was a slight but noticeable reduction in reactions to the exercises as they progressed from individual to collective training. TC comments were that they wanted more integration time as a crew and as a platoon.

TCs were also asked a summary question about how they perceived the overall adequacy of the hands-on training practice in using the equipment in all the events. As shown in Table 29, the opportunity for hands-on practice was rated very close to good.

As a measure of the quality of training received, the TCs were asked to rate the clarity of provided training. As shown in Table 30, the average ratings were all well above the midpoint indicating the training was perceived as clear. The mean ratings were slightly higher for the training objectives and the information on how to operate the equipment compared to the information on tactical operation and training feedback on performance.

Table 29

Tank Commander Evaluations of Tactical Training Exercises

How helpful were the tactical training exercises in preparing you to use the VIDS sensors and countermeasures in a tactical situation?	M	SD
VIDS hands-on training	3.81	0.66
Crew integration exercise	3.50	0.63
Platoon training exercise (STX)	3.44	0.81
How helpful was the opportunity for hands-on practice using the equipment in the events listed?	3.81	.75

Note. N = 16. Ratings were made on a 5-point scale where 1 = Poor and 5 = Excellent. VIDS = Vehicle Integrated Defense System.

Table 30

Tank Commander Evaluations of Clarity of Training

Considering the training as a whole, how clear were the following?	M	SD
Training objectives (what you were expecting to learn)	4.13	0.62
Information on how to operate the the equipment	4.25	0.58
Information on how to operate the equipment tactically	3.94	0.77
Feedback on how well you were performing during training	3.94	0.44

Note: N = 16. Ratings were made on a 5-point scale where 1 = Poor and 5 = Excellent.

Gunners and driver. Gunners and drivers were queried on their views of the training program. They both were asked to rate how the three training components (classroom instruction, hands-on instruction, and training exercises) prepared them for participating in the evaluation. Although their ratings were above the midpoint, as summarized in Table 31, their component ratings were dissimilar. Gunners rated classroom and hands-on instruction somewhat higher than the training exercises whereas the drivers

Table 31

Gunner and Driver Evaluations of Training

	Gunners		Drivers	
	M	SD	M	SD
Classroom instruction	3.88	0.62	3.38	0.50
Hands-on instruction	3.94	0.68	3.63	0.62
Training exercises	3.38	1.20	3.81	0.83

Note. N = 16 for gunners and drivers each. Ratings were made on a 5-point scale where 1 = Poor and 5 = Excellent.

rated training exercises and hands-on instruction somewhat higher than classroom instruction. There were a couple of possibilities as to why they rated the components differently. The gunners may have been more adversely affected by the training exercises. Several comments from gunners (25% of gunners) linked their low ratings to frustration associated with computer problems (i.e., computer generated imagery) and its interference with gunnery. Drivers, although somewhat affected by computer imagery problems, had more opportunity to participate in the exercises than in the other training.

Training outcomes. Performance outcomes were examined using the outcomes from the TCs' VIDS Skill Test given upon conclusion of the TCs' individual VIDS training, but prior to crew integration training. This test was used as a diagnostic gate prior to the start the collective phase of training. The test was composed of nine items: five knowledge and four performance items related to the successful operation and understanding of the VIDS. The TC was scored and corrected before going to the next item. All performance items had critical components that had to be 100% correct with the opportunity to retest on alternate items if failed the first time. For 16 TCs, one missed one knowledge item resulting in an overall score of 99.31% correct for all TCs. According to these results, the TCs mastered the training program and were able to start the collective training without delay.

Sub-issue b: How Sufficient Was the Amount of Time Devoted to Training the Specific Functions of the Equipment?

Data on this issue were gathered using sections of the TC evaluation questionnaire. This subsection of the questionnaire identified specific functions for usage of the VIDS equipment and asked the TCs to rate if training time should be increased, kept the same, or decreased for classroom and individual instruction separately.

Table 32 summarizes the ratings data on training time needed for all VIDS functions as trained in this evaluation. (Not all VIDS submenu functions were used and thus were not trained.) The first tabled column lists the specific functions they were asked to rate. The next two sets of columns presents the mean and standard deviations for the classroom instruction and individual instruction ratings, respectively.

The data in Table 32 revealed two major tendencies in TCs ratings for training time on VIDS functions. First, average ratings for classroom instruction were below the midpoint of the scale suggesting that some reduction in training time (i.e., between 100% and 50%) was needed. However, large standard deviations indicated there was considerable variability in TCs views as to which components were to be decreased, especially for CCDP target select key, scroll key, threat icon symbols, threat coordinate field and overall

Table 32

Training Time Needed for VIDS Functions

Based on your experience with our training program, do you feel training time in an evaluation like this should be increased or decreased?

	Classroom		Individual	
	M	SD	M	SD
CCDP functions				
POWER FFK	2.37	0.81	3.31	0.95
ENTER FFK	2.44	0.89	3.19	0.83
DSPLY FFK	2.37	0.81	3.38	0.96
TGTSEL FFK	2.63	1.26	3.56	1.15
SCROLL FFKs	2.56	1.09	3.44	0.96
MAIN FFK	2.37	0.81	3.13	0.89
NORM FFK	2.37	0.81	3.13	0.89
Audible alerts	2.38	0.89	3.13	0.89
Threat icon symbols	2.56	1.21	3.38	1.15
CM SELECT field	2.37	0.81	3.19	0.91
CM STORES field	2.37	0.81	3.19	0.91
THREAT COORDINATE field	2.56	1.03	3.38	0.96
Alert indicator	2.44	0.89	3.19	0.91
Tank icon	2.37	0.81	3.13	0.89
Sectors	2.44	0.73	3.13	0.89
CCH functions				
VIDS activation button	2.56	0.73	3.25	0.86
VIDS functions overall				
Using semi-automatic mode	2.44	0.73	3.13	1.09
Using automatic mode	2.56	1.03	3.38	1.20
Performing main gun counterfire	2.94	1.18	3.81	1.05
Deleting icons after counterfire	2.69	0.95	3.44	1.31

Note. *N* = 16. Ratings were made on a 6-point scale where 1 = *1/4 as much*, 2 = *1/2 as much*, 3 = *no change*, 4 = *1/4 as much again*, 5 = *1/2 as much again*, and 6 = *twice as much again*. CCDP = Commander's Controls and Display Panel; CCH = Commander's Control Handle; VIDS = Vehicle Integrated Defense System.

VIDS functions using automatic mode, and performing main gun counterfire. Although these data are useful to review cutting classroom training time, such cuts should be made cautiously.

Second, ratings for individual instruction exceeded the midpoint of the scale indicating that more training time (0% to 25% more) should be devoted to hands-on training in the simulators. As with the classroom instruction, the standard deviations were quite large, especially for CCDP target select functions, threat icon symbols, and all four VIDS overall functions. The corresponding overlap of variability of CCDP target select and threat icon symbology, the overall VIDS functions using automatic mode, and performing main gun counterfire suggests that these areas of instruction need careful consideration in decreasing or increasing time in individual versus classroom instruction. Overall, soldier comments tended to indicate that more hands-on instruction was needed with less classroom instruction.

Sub-issue c: How Easy Was It to Learn to Use the Equipment?

This issue was addressed by asking TCs to rate how easy or difficult it was to learn the functions necessary to operate the VIDS. The same functions included in the issue on training time (described above) were used to address this issue.

Table 33 presents the summarized ratings for ease of learning VIDS functions. Functions were organized into CCDP, CCH, and VIDS functions overall. On the average, all functions were regarded as easy to very easy to learn except for performing main gun counterfire and deleting icons after counterfire. The function, deleting icons after counterfire, was rated between easy to neutral on the scale with quite a bit of variability associated with that rating. Also, performing main gun counterfire was rated above the midpoint of the scale toward difficult to learn. This function also had an increased variability of TC response associated with it. Both functions were related sequentially, with the TC having to delete icons after counterfire to signal the end of an engagement to the VIDS system. These two functions taken together were the most complex functions trained. TC comments mention counterfire functions as the most troublesome and frustrating aspects of the VIDS system.

Table 33

Ease of Learning for VIDS Functions

How easy was it to learn each of the following VIDs functions?	M	SD
CCDP Functions		
POWER FFK	1.38	0.50
ENTER FFK	1.38	0.50
DISPLAY	1.50	0.63
TGTSEL FFK	1.63	0.89
SCROLL FFKs	1.63	0.89
MAIN FFK	1.44	0.51
NORM FFK	1.44	0.51
Audible Alerts	1.62	0.62
Threat Icon Symbols	1.69	0.79
CM SELECT Field	1.44	0.51
CM STORES Field	1.44	0.51
THREAT COORDINATE Field	1.81	0.98
Alert Indicator	1.50	0.52
Tank Icon	1.69	0.79
Sectors	1.62	0.62
CCH Functions		
VIDS Activation Button	1.69	0.60
VIDS Functions Overall		
Using semi-automatic mode	1.88	0.89
Using automatic mode	1.94	1.00
Performing main gun counterfire	3.12	1.15
Deleting icons after counterfire	2.38	1.36

Note. N = 16. Ratings were made on a 5-point scale where 1 = Very Easy and 5 = Very Difficult. VIDS = Vehicle Integrated Defense System.

Sub-issue d: What Would Be the Training Requirements (Type and Length of Training) to Prepare Tankers to Use This Type of Equipment If It Were Fielded?

This issue was addressed in two sections of the training questionnaire. In both sections, TCs were asked to imagine that they were members of the New Equipment Training Team (NETT) with the mission to develop the transition training and the program of instruction (POI) for M1 qualified tankers. The first section asked the TCs to make projections about the amount of time required for training a list of VIDS associated task functions. The second section asked the TCs to make projections about the best type of training (simulator, tank, or both) required to train the associated task functions.

Table 34 provides a summary of the TCs' projections about the amount of time required to teach the VIDS in a NETT environment. The first column lists the task functions. The first four functions are directly related to VIDS tasks. The last three functions are tasks that would be affected by the introduction of the VIDS. The second column contains the means and standard deviations associated with the estimated POI hours needed for training the task functions.

Table 34

Time to Train Training on New Equipment: VIDS Task Functions

Task	POI Hours	
	M	SD
Sense and determine relative direction of threats	1.08	0.91
Identify and determine the most dangerous threats	1.05	0.90
Avoid and counter threat munitions	1.61	1.06
Counter and defeat threat platforms	1.56	1.01
Perform integrated crew operations	4.31	2.85
Tactically maneuver at the platoon level	2.37	0.50
Prepare battlefield reports (with CCDP information)	2.19	0.91

Note: N = 16. Responses were made in time from 15 minutes to 8 hours, using 15 minute increments. Responses were converted to hours for analytic purposes. VIDS = Vehicle Integrated Defense System.

As seen in Table 34, the first four VIDS associated tasks were estimated to be trained from slightly over 1 hr to just over 1 1/2 hr, averaging about 1 hr 20 min per task function. The last three functions range from 4 1/2 hr to slightly over 2 1/3 hr, with extreme TC rating variability associated with training crew integration. It was interesting to note that the VIDS task functions were estimated to take much less time to train than the task functions VIDS would have an impact on. Probably the more direct VIDS tasks were perceived as easy to learn because the VIDS functions were largely automated. The indirect tasks that the VIDS would have an impact on involved the introduction of VIDs into collective (crew and platoon) tasks or a more complex task like integrating VIDS information into reports.

In interpreting the new equipment training requirements, it was interesting to compare them to the

research training program phases that contained the tasks associated with them. Roughly 4 hr were used to train the hands-on portion that included the first four VIDS tasks as compared to the 5 hr 18 min average projected by the TCs for the NETT POI hours. Crew integration training lasted 1 3/4 hr compared to the 4 1/3 hr estimated for NETT training. Some TC comments reflected a desire to spend more time in crew integration training. Platoon level training required much more time in the training program than the estimated time: six and one-half hours compared to slightly over two and one-third hours estimated for the NETT POI. However, the training program trained both offensive maneuver and defense plus two different VIDS configurations with alternating modes. If the training program time is adjusted (using the Offensive STX and figuring only one suite was trained) then compared to the NETT POI estimate, the training program versus NETT POI estimate would be 1 hour, 52 minutes versus 2 hours, 22 minutes; a 1/2 hr increase over the training program. The battlefield report task training was integrated into individual through collective training and could not be separated for interpretation.

Given their training program experience, the TCs recommended more time was needed to train when the system would be fielded. TCs perceived that slightly more time was needed to train the direct VIDS tasks, almost three times the amount needed to train crew integration tasks, and slightly more time was needed to train platoon maneuver with VIDS. The TCs apparently perceived that the VIDS had the largest impact on crew tasks versus individual and platoon level operations. Recommendations for the type of new equipment training are provided in Table 35.

Table 35 summarizes the TC's judgements about the type of new equipment training required for the same VIDS task functions. For each task function, the percent of TCs indicating that training would be needed on simulators, real tank, or both are presented.

Table 35

Tank Commander's Recommendations for Type of Training on New Equipment: Percentage of Time Spent on VIDS Task Functions

Task	Method		
	Simulator	Tank	Both
Sense and determine relative direction of threats	56%	19%	25%
Identify and determine the most dangerous threats	56%	19%	25%
Avoid and counter threat munitions	62%	19%	19%
Counter and defeat threat positions	50%	12%	38%
Perform integrated crew operations	19%	31%	50%
Tactically maneuver at the platoon level	0%	62%	38%
Prepare battlefield reports (with CCDP information)	31%	19%	50%

Note. Percentages based on N = 16. VIDS = Vehicle Integrated Defense System.

In general, the simulator was the preferred type of training for the direct VIDS task functions whereas the tank or a combination of tank and simulator training was seen as the type of training needed for the

more complex individual, crew, and collective tasks. Half or more of the TCs projected that the simulator would be the preferred method for training the first four VIDS related tasks, with about 25% indicating a combination of both types of training would be preferred. For performing crew integration functions with VIDS, half of the TCs preferred using both methods while about a third of the TCs preferred using the real tank for the training. Half of the TCs preferred using both methods to train the preparation of battlefield reports, with almost a third preferring the training to be done in the simulator. Interestingly, almost two-thirds of the TCs preferred using the real tank to train platoon tactical maneuver with VIDS, with slightly over one-third preferring a combination of both methods for training. The preference for the real tanks was undoubtedly due to the frustration experienced by the TCs during the platoon STX just prior to administering this questionnaire. Many questionnaire comments were directed at the simulator problems with poor computer imagery and disorientation when smoke was employed in the simulation.

In summary, recommended training time estimates for fielded VIDS equipment was on the average about 1 1/2 hr per task function--preferably conducted in the simulator. The time needed for the VIDS functions was somewhat underestimated because only the most direct operational tasks were trained in the training program. If all the setup menu functions had been trained, these time estimates would probably be doubled or tripled. TCs recommended using a combination of simulator and real tank training and spending 4 1/3 hr to train integration of VIDS into crew operations. Recommendations for training TCs to integrate CCDP information into battlefield reports included spending about 2 hr 12 min to train using a combination of simulator and real tank. TCs recommended using the real tank for over 2 1/3 hr to train tactical platoon maneuver with the VIDS. Undoubtedly, this was an underestimate given field training usually would require more time. Given their limited experience with platoon training prior to making this rating, this recommendation needs to be cautiously interpreted.

Sub-issue e: What Are the Soldier Participant Comments for Improving the Training?

This final training issue was addressed by examining open-ended comments made by soldier-participants on their training evaluation questionnaire and during the final debriefing. The listings of comments from both sources were reviewed to identify suggestions either having merit in regard to the training program or frequently suggested by different participants.

Table 36 identifies suggestions for improving the training program. The suggestions were organized into six major categories: classroom, hands-on simulator training, demonstrations, roundtable discussions, tactical exercises, and simulator/simulation improvement.

Participants suggested that any classroom sessions should provide an outline (or the script) if the briefing or training is lengthy, tightly scripted, and briefed. They did not appreciate classroom sessions in which training scripts were read to them.

Suggestions for improving hands-on training included requests for more navigation training for the TCs and more VIDS hands-on training for the gunners and drivers. The navigation training was requested partly because of navigating in the simulated battlefield. Also, TCs felt more navigation training was needed at the platoon level because the platoon would often get disoriented during and after a battle. Possibly, platoon level integration and navigation training need to be added to allow the platoon time to work out procedures for platoon navigation. (It was noted that some platoons were more successful when designating a TC to be their primary navigator.) The suggestion for crosstraining came from both the gunners and drivers. Both felt they would have been able to assist the TC better if they had the opportunity to train on the VIDS. Their desire to crosstrain partly was due to the fact that they did not receive as much hands-on training as the TCs. Also, there was a genuine desire to know how the VIDS operated so they could provide more assistance to the TC during VIDS operations.

The suggestion about providing the gunners and drivers with only the large screen CCDP demonstration was made by several TCs. Mainly, the TCs felt the material was redundant to what they received during their hands-on training. They felt the hands-on portion was more directive because the RAs were there to

Table 36

Soldier-Participant Suggestions for Improving the Training Program

Classroom
Include introductory script/outline as handout.
Hands-on simulator
Include more navigation practice.
Include VIDS cross training.
Demonstrations
Give CCDP demonstration to gunners and drivers only.
Roundtable discussions
Include visual aids.
Tactical exercises
Replay STX as AAR for platoon feedback.
Simulator/simulation improvement
Add thermal imagery sight (TIS).
Fix computer imagery problems.

Note. VIDS = Vehicle Integrated Defense System; CCDP = Commander's Controls and Display Panel; STX = Situational Training Exercise; AAR = After Action Review.

coach them individually. Further, they recommended that they be excused from the demonstration.

Both gunners and drivers thought the roundtable discussion was extremely beneficial. It was suggested that including visual aids of how the system worked during the discussion would have provided more benefit.

Some of the soldier-participants were M1A2 NETT members and had worked extensively in the MWTB. Some of those members suggested that using the Stealth to replay the STX for an AAR would have assisted the platoon during the feedback process.

Equipment problems sometimes interfered with the training process. Several suggestions were made about fixes to the simulator and simulation which impact on training. First soldiers felt that if smoke was to be generated in the simulation, there should be a way to see through it like on the real tank. They felt they were at an extreme disadvantage without a thermal imagery sight (TIS) which would have allowed them to acquire the enemy through the visual smoke. Thus, they suggested adding a TIS to the simulator. Another problem that occurred throughout training, especially when smoke was generated, was the problem with slow updates and jerkiness of computer generated imagery in vision blocks and sights. This caused the soldier-participants much frustration when maneuvering and engaging the enemy. Numerous comments stressed the need to fix the imagery problems in order to provide better training.

Summary of Training Findings

Results for the training portion of the evaluation issue were organized around five training sub-issues. Key findings for each training sub-issue are summarized as follows.

Training program adequacy. This sub-issue examined the adequacy of the training materials and procedures used to prepare the soldier-participants to operate the equipment. Results indicated that the TCs had an overall favorable view of the training provided. The TCs tended to rate hands-on instruction higher than the classroom instruction and demonstrations. They also rated tactical exercise training as positive, with individual hands-on exercises receiving higher ratings than crew and platoon exercises. All training was perceived as clear with training objectives and equipment operation information rated better for clarity than tactical operation information and training performance feedback.

Gunners and drivers perceived the training as more than adequate. However, the gunners and drivers tended to diverge on the training components they favored. Gunners tended to rate the classroom and hands-on instruction higher than the tactical exercises, whereas drivers rated the hands-on instruction and tactical exercises higher than the classroom instruction. It was thought the gunners may have experienced more frustration in gunnery operations in tactical exercises, hence the lower ratings. Drivers may have felt more involved in hands-on instruction and tactical exercises than in classroom instruction.

Training program adequacy was further explored by examining the performance of TCs after they completed individual VIDS training. VIDS Skill Test results indicated the TCs were ready to operate the VIDS.

Sufficiency of training time. This sub-issue examined how sufficient was the allotted training time for each of the VIDS functions in the training program. In general, TCs perceived the classroom training as sufficient, but lengthy, whereas they thought the individual hands-on instruction time could be increased. Specific items that could be reduced in the classroom and increased in the hands-on portion were: CCDP threat icon symbol and target (delete) selection functions, use of automatic mode, and performing main gun counterfire.

Ease of learning. This sub-issue focused on how easy or difficult it was to learn to use the VIDS equipment. Generally, the TCs rated CCDP functions and CCH functions as easy to learn. They also viewed most VIDS functions easy to learn. The exceptions were performing main gun counterfire and deleting icons from the CCDP screen after counterfire. These two sequential functions, relative to other functions, were the most difficult to learn.

Training requirements for the VIDS. This sub-issue assessed the length and type of training that would be required to train M1/M1A1 qualified soldiers if VIDS were fielded. Generally, the TCs felt that field training would require more time than what they had received in the training program. NETT training for four directly related VIDS task functions required about an average of 1 1/3 hr using the simulator. However, if the CCDP setup menus were trained, this estimated training time could easily triple. Indirect tasks that VIDS would affect required more time to train and involved differing training methods. Preparing battlefield reports using CCDP information was viewed as requiring 2 1/5 hr using a combination of simulator and real tank. Training the incorporation of VIDS into crew functions was seen as taking the longest time (i.e., over 4 1/3 hr) using a combination of simulator and real tank. Training platoons to maneuver while using VIDS was viewed as taking over 2 1/3 hr using the real tank. The last estimate was considered an underestimate of time required to train on the real tank in a field setting.

Suggestion for training program improvement. This sub-issue was directed at soliciting soldier-participant suggestions for improving the training program. Several recommendations directed at improving specific components of the training program were made in five areas: classroom instruction, hands-on training, demonstrations, roundtable discussions, tactical exercises, and simulator/simulation improvement.

Soldier-Machine Interface (SMI)

This subsection is organized according to four sub-issues to investigate the SMI component of the evaluation issue mentioned at the beginning of this section. The four sub-issues, in the form of answerable questions are:

(a) Is the VIDS SMI acceptable to users?

(b) What is the task workload associated with the VIDS?

(c) How does the VIDS interface affect equipment usage?

(d) What are the soldier-participant comments for improving the VIDS design?

An SMI questionnaire was used to assess the acceptability of the VIDS features and functions as used in this evaluation. (Not all features and functions were used in interest of controlling experimental conditions.) User acceptability ratings were considered a critical method for identifying features and functions for possible VIDS design improvement. Task workload assessments were used to identify increases or decreases in workload on key tasks and possibly the type of workload distribution on those tasks. The results of these assessments were considered for identifying possible design, procedural, or training improvements for the VIDS. Visual equipment usage was expected to be affected with the introduction of the VIDS into the TC's station. RA ratings of differential distribution of the various visual devices were examined to identify the impact the CCDP would have in the different configurations and among the platoon members. Soldier-participant comments from the SMI questionnaire and final debrief were examined to identify specific recommendations for design improvements.

Sub-issue a: Is the VIDS SMI Acceptable to Users?

The SMI questionnaire was administered to TCs after they completed all test scenarios and the final debrief. As users, the TCs rated the user acceptability of the VIDS features and functions. Table 37 provides the summary acceptability ratings of the VIDS features and functions used in this evaluation. (Sensor, CM, and CF setup functions were not trained or used by the TCs for this evaluation and therefore were not subject to evaluation.) The table presents specific features or functions organized into general component areas: general VIDS functions, fixed function keys, programmable function keys, information displays, warning system, counterfire, icon deletion, automatic mode, and semi-automatic mode. The first and second columns present the associated means and standard deviations, respectively.

Table 37

Summary of Tank Commander Acceptability Ratings of VIDS Features and Functions: Means and Standard Deviations

	M	SD
General VIDS functions		
Location of the CCDP in the simulator	3.56	1.15
Graphic quality of information on CCDP	4.06	1.07
Touch screen input	2.50	1.37
Color coding of screen	3.44	1.36
Commander's Control Handle	3.81	1.17
Fixed function keys (FFKs)		
Arrangement of keys on screen	4.00	.89
Size of keys	4.06	1.06
Number of keys	3.69	1.20
Understandability of labels	3.62	1.15
Responsiveness of keys after touching	3.75	1.18

(Table Continues)

	M	SD
Programmable function keys (PFKs)		
Location of keys on screen	4.06	1.00
Labelling of keys	3.94	1.06
Touching ENTER key to activate programmable keys	4.13	1.09
Understandability of menu hierarchy	3.94	.85
Ability to identify the menu in which you are operating	4.06	1.06
Information displays		
Amount of information in "CM SELECT" field	4.31	.60
Understandability of information in "CM SELECT"	4.19	.83
Amount of information in "CM STORES" field	4.31	.70
Understandability of information in "CM STORES"	4.13	.89
Amount of information in Threat Coordinates field	3.37	1.20
Understandability of information in Threat Coordinate Field	3.81	1.11
Understandability of information in Mode Indicator	4.00	.97
Threat icons	3.75	1.06
Ability to scroll through threat information	3.27	1.44
Overall clarity of information	3.63	1.09
Overall amount of information presented	3.75	1.00
Priority of threat information	2.75	1.39
Alert signals		
Auditory alert signals	3.56	1.09
Voice message alerts	3.13	.89
Error message alerts	3.38	.81
Counterfire		
Touching TGTSEL FFK to signal end of engagement	2.13	1.41
Icon deletion		
Automatic deletion of inactive threat icons	3.00	1.41
Manual deletion (using SCROLL and TGTSEL FFKs)	2.50	1.26
Automatic mode		
Prioritization of threats	2.25	1.06
Main gun automatically slewing to threat vicinity	1.38	.81
VIDS choice of countermeasure	3.44	1.41
Semi-automatic mode		
Engaging thumb switch for VIDS activation	3.62	1.15
Your ability to control VIDS	3.56	1.26
Amount of time to react to threat warning	3.75	1.06

Note. N = 16. Ratings were made on a 5-point scale where 1 = Totally Unacceptable and 5 = Totally Acceptable. VIDS = Vehicle Integrated Defense System; CCDP = Commander's Controls and Display Panel.

Overall, the results in Table 37 indicated the TCs felt that most VIDS features and functions were acceptable. However, the mean ratings were extremely variable as indicated by the large standard deviations and any interpretations of favorable acceptance should be cautiously applied. Primarily, this analysis focuses on the features and functions that appeared to be rated less acceptable.

For the general VIDS functions, the only less than acceptable rating was the CCDP touch screen input. Although the TCs had been briefed that the computer touch screen input was there for rapid prototype changes (i.e., button changes between configurations), they apparently still thought that this feature was undesirable for implementation for a real tank. TCs commented that there should be hard-wired buttons for the real tank and mentioned the possibility of selecting the wrong button while on the move.

For the Information Display functions, a less than acceptable rating was the way the priority of threats were displayed. The most dangerous threat was always the blinking icon which could be a munitions, a weapon platform, or an unknown threat (or friendly). Also, direction was shown relative to the tank hull while distance to the threat was not. Several TCs commented that the displayed priority threat was not always the closest and/or most dangerous threat. One example given in discussions was the immediate tank threat at 1000 m but an unseen helicopter displayed as the threat. The CCDP displays several threats at one time but the last active threat in the queue is the highest priority. A possibility (especially with VIDS configurations 3 and 4) was the displayed priority threat (blinking icon) was not what counterfire always designated. That is, under simultaneous conditions, the highest priority threat may have been countered by a CM (like CPS) and the counterfire oriented to a second threat, a long distance HIND firing an out-of-visual range ATGM. However, it was possible that sensor input and threat resolution logic still needed modifications for displaying the highest priority of simultaneous threats.

The Counterfire function, touching the TGTSEL fixed function key to signal end of engagement, received less than acceptable ratings. After a successful main gun engagement in which the main gun had slewed to the target (counterfire), the procedure was to either select the target, if it was still a priority, or scroll down to it and then push the TGTSEL fixed function key to delete it from the display, thus returning the VIDS system to operation. TCs found this to be a cumbersome procedure and some indicated that the icon did not disappear or that the procedure did not work (especially when the queue appeared overloaded). It was unknown whether the VIDS system did not work or if the processing overload in the system caused the problems. Nevertheless, the procedure for signalling the system to return to operation was inefficient and possibly ineffective.

An associated function which also received a less than acceptable rating was the manual method for icon deletion. If the TC wanted to delete an icon that was not blinking (highest priority), he had to use the SCROLL UP or SCROLL DOWN fixed function keys to locate the icon. The icons blinked as the TC scrolled through the threat queue. The last active icon was returned automatically to the bottom of the queue which meant scrolling through all the icons to reach that icon for deletion. Once the icon started blinking, the TGTSEL fixed function key had to be pushed, to delete it from the system. A complaint about this function was that it did not appear to work. Some TCs said the icon would reappear momentarily after it was deleted. The same comment was made about the inactive icons that were automatically deleted. It is notable that automatic icon deletion was rated neither acceptable nor unacceptable. Obviously, icon deletion was perceived as a problem for this system. Some TCs suggested using the touchscreen as a method for deleting threats from the queue by selecting an icon directly and using the TGTSEL button.

Two Automatic Mode functions were rated less than acceptable: prioritization of threats and automatic main gun slew (counterfire). These two functions were closely related. The TCs, in general, want to have control of their tank. They especially did not like losing control of their turret. When the automatic mode was used, especially in configurations 3 and 4, the main gun counterfire system would often slew their main gun tube to the general azimuth of the system designated threat. Sometimes, according to TC comments, the designated target was not visible (i.e., a HIND out of visual range), a dead burning vehicle, or one of the other platoon elements. Target prioritization was especially problematic in target rich environments. In these situations, priority threats would constantly switch based on which threat was close to the sensing vehicle. Possibly, these events accounted for the poor ratings and comments about the priority system not working or that the threat priority should be determined by the TC.

In summary, only a few features and functions were rated less than acceptable. The less than acceptable functions related to the touch screen input feature, the assignment and display of priority threats, icon

deletion functions, end of engagement procedures, and main gun counterfire. Most of the favorable ratings were highly variable, indicating that the TCs were somewhat divided on their acceptability ratings. The VIDS interface was not used in depth in terms of all its features (e.g., CM, CF, and safety sectors) and functions (e.g., extensive setup menus for setting sensor limits, CMs and CF sectors, display characteristics, operational modes, etc.). In this respect, the SMI acceptability of the user interface was lacking. Additionally, this evaluation did not require the operator to extensively interact with the system, therefore ratings are based on a somewhat limited use of the system. The favorable acceptability of most of the features and functions need to be interpreted cautiously.

Sub-issue b: What Is the Task Workload Associated With the VIDS?

Workload assessments have been performed in previous MWTB research efforts (Morey, Wigginton, and O'Brien, 1992; O'Brien, Wigginton, Morey, Leibrecht, Ainslie, and Sawyer, 1992) to refine workload assessment methodology and examine the impact that new equipment has on operators when performing concurrent tasks. The approach developed by Morey et al (1992) for using the National Aeronautics and Space Administrations's Task Load Index (NASA-TLX) rating procedure was used to conduct the workload assessments for this evaluation. Workload for Plt Ldr tasks and TC tasks was assessed to determine the relative "costs" the operators incurred as a result of the VIDS introduction into the TC's environment. Workload assessments were conducted to measure the relative effects of the different VIDS configuration on the tasks performed and determine the operator task loadings required to perform the tasks. Task loading information was thought to provide insight into how a particular VIDS configuration and/or mode was affecting the associated task. The six domains of task loadings included: mental demand, physical demand, time demand, performance, effort, and frustration. (For a definition of each of these loadings see either workload assessment instrument presented in Appendix G.)

Workload assessment ratings were collected from Plt Ldrs and TCs on respective tasks at the conclusion of each block of three scenarios for each baseline and VIDS configuration (and mode). Plt Ldr tasks included: coordinate sector searches, direct platoon maneuver, and direct platoon fires. TC tasks included: acquire targets, engage targets, evade ATGMs, prepare and send CONTACT reports, and prepare and send SPOT reports.

Main effects for Task, Configuration, and Mode and interactions for Task by Configuration, Configuration by Mode, and Task by Configuration by Mode were statistically analyzed for detecting significant differences. If differences were found for any of the effects, the mean workload differences were compared to determine trends.

The workload assessment for the Plt Ldr tasks revealed only one significant finding. The main effect for Task was significant (F (2,6) = 7.65, p = .022). Multiple comparison tests conducted between the tasks revealed no significant differences between the tasks. As such, no further analysis was conducted for the Plt Ldr tasks.

The workload assessment for the TC tasks revealed significant effects for Task (F (4, 60) = 4.59, p = .003), Configuration (F (3, 45) = 8.08, p < .001), and the Task by Configuration interaction (F (12, 180) = 2.39, p = .007). Effects for Mode and associated interactions were not significant. Tables 38 and 39 present the mean workload ratings for the main effects of Task and Configuration, respectively.

Interestingly, mean workload ratings for tasks (see Table 38) were significantly lower for the reporting tasks than for acquire targets and evade ATGM, two tasks more directly related to VIDS operations. Engage targets was higher also, but the standard deviation indicates more variable TC response to this task. Task differences were to be expected. No further interpretation was planned for the purposes of this evaluation.

Table 39 presents the mean workload rating for Configuration. Notably, only Configuration 4 was significantly different from the baseline and other two VIDS configurations. Figure 13 illustrates the

Table 38

Workload Ratings for Tank Commander Tasks: Means, Standard Deviations (in parentheses), and Statistical Comparison Results

Task				
Acquire Targets	Engage Targets	Evade ATGMs	Prepare/Send CONTACT Reports	Prepare/Send SPOT Reports
9.18_a (1.65)	8.89 (2.23)	8.73_a (1.96)	7.68_b (1.95)	7.69_b (1.97)

Note. N = 16. Ratings range from 0 (lowest workload) to 20 (highest workload). Means in the same row with different letters differ significantly at $p < .01$, one-tailed for the Bonferroni t test. ATGMs = Anti-Tank Guided Missiles.

Table 39

Workload Ratings for Configuration: Means, Standard Deviations (in parentheses), and Statistical Comparison Results

Configuration			
Baseline	1	3	4
8.00_a (1.12)	7.62_a (1.88)	8.72_a (2.12)	9.38_b (2.06)

Note. $N = 16$. Ratings range from 0 (lowest workload) to 20 (highest workload). Means in the same row with different letters differ significantly at $p < .017$, one-tailed for the Bonferroni t test.

relationship between the four configurations. Although the trend is not quite linear when considering the baseline configuration, an increase in TC workload is seen between the VIDS configurations as one progresses to configuration 4. Even though added protection was provided by increasing the sensors and countermeasures for each configuration, TC workload increased accordingly. A possible contributing factor to the corresponding increase in workload was the counterfire problem mentioned earlier in this section. Apparently, automated counterfire increasingly caused problems in each successive VIDS configuration. Fighting the VIDS system for control of the turret may have contributed to the workload ratings. Configuration 4 appeared to have worst counterfire problems, possibly due to the addition of the muzzle flash detector which provided more threat input into the threat queue.

Table 40 presents the mean TC workload ratings for the Task by Configuration interaction. No tasks had significant configuration differences between baseline and VIDS configurations. Preparing and sending reports tended to be relatively easier to perform considering all the tasks. Generally, acquiring and engaging targets tended to be associated with relatively more workload, especially with the VIDS configurations.

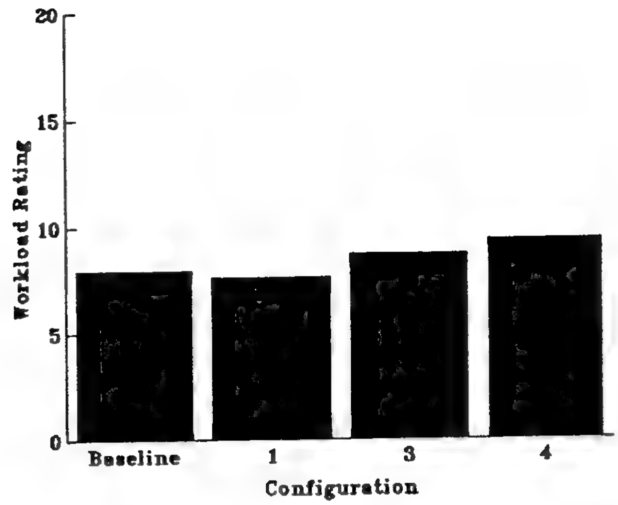

Figure 13. Tank commander mean workload ratings by configuration.

Table 40

Workload Ratings for Task by Configuration Interaction: Means, Standard Deviations (in parentheses), and Statistical Comparison Results

Task	Configuration			
	Baseline	1	3	4
Acquire targets	8.67 (1.47)	8.06_a (1.92)	9.44_b (2.23)	10.54_b (2.52)
Engage targets	8.05 (2.68)	8.10_a 2.26)	9.38 (2.70)	10.03_b (2.53)
Evade ATGMs	9.10 (1.76)	7.80 2.47)	8.70 (8.70)	9.31 2.47)
Prepare/Send a CONTACT report	7.18 (1.21)	6.95_a (2.21)	8.10 (2.52)	8.48_b (2.72)
Prepare/Send a SPOT report	7.01 (1.37)	7.18_a (2.25)	8.00 (2.68)	8.55_b (2.58)

Note. $N = 16$. Ratings range from 0 (lowest workload) to 20 (highest workload). Means in the same row with different letters differ significantly at $p < .003$, Bonferroni t test. ATGMs = Anti-Tank Guided Missiles.

All tasks by task loading rating interactions were significant: acquire targets (F (5, 75) = 8.86, $p <$ .001), engage targets (F (5, 75) = 7.38, $p < .001$), evade ATGMs (F (5, 75) = 6.91, $p < .001$), prepare and send CONTACT reports (F (5, 75) = 5.90, $p < .001$), and prepare and send SPOT reports (F (5, 75) = 5.74,

p < .001). Table 41 presents the mean task loading ratings for each task. A noted consistent trend across tasks was that Frustration task loading was significantly higher, especially when compared against Physical Demand and Performance. Frustration was indicative of attitude toward the task (i.e., secure or insecure, gratified or discouraged, or relaxed or stressed). TCs may have felt more discouraged or stressed when using the VIDS configurations, especially VIDS configurations 3 and 4.

Table 41

Task Load Ratings for Tank Commander Tasks: Means, Standard Deviations (in parentheses), and Statistical Comparison Results

	Task Loadings					
Task	Mental Demand	Physical Demand	Time Demand	Performance	Effort	Frustration
Acquire Targets	9.88 (3.64)	$7.06_{-,a}$ (2.51)	9.79 (3.06)	$6.71_{a,-}$ (2.14)	$10.39_{b,-}$ (2.70)	$11.23_{b,b}$ (2.56)
Engage Targets	9.11 (3.57)	6.82_{a} (2.61)	9.59 (3.60)	6.57_{a} (2.91)	10.38 (3.88)	10.88_{b} (3.04)
Evade ATGMs	9.50 (3.03)	6.85_{a} (2.44)	8.98 (2.96)	7.05_{a} (2.87)	9.76 (2.99)	10.21_{b} (2.43)
Prepare/Send CONTACT Reports	8.45 (2.76)	6.01_{a} (2.73)	8.37 (2.71)	5.70_{a} (2.59)	9.31 (3.09)	8.22_{b} (3.65)
Prepare/Send SPOT Reports	8.60 (3.07)	5.92_{a} (2.69)	8.28 (2.75)	5.73_{a} (2.84)	9.30 (3.36)	8.29_{b} (3.26)

Note. N = 16. Ratings range from 0 (lowest workload) to 20 (highest workload). Means in the same row with different letters differ significantly at $p < .001$, Bonferroni t test. Means with sets of letters are significantly comparable across first letters and second letters, respectively. A dash indicates no comparison. ATGMs = Anti-Tank Guided Missiles.

Figure 14 provides an illustration of the comparable Frustration ratings across tasks by configuration. As shown, the relative ratings were higher for VIDS configurations 3 and 4 compared to baseline and VIDS configuration 1. In an SMI questionnaire item related to the increase or decrease in stress related to VIDS configurations, 12 of 16 TCs reported that stress levels increased. Cited reasons for increased stress were primarily related to loss of control in automatic mode (i.e., smoke deployment) and during automated counterfire. Semi-automatic mode was primarily in automatic mode once activated, and counterfire activations were more prevalent in configurations 3 and 4. Possibly, the general increase in Frustration ratings for configurations 3 and 4 (see Figure 14) were related to increased loss of control experienced in these two configurations.

Although all Task Loadings by Configuration interactions were significant for all five tasks, the multiple comparison tests revealed few significant differences. Therefore, these interactions are not subjected to further investigation.

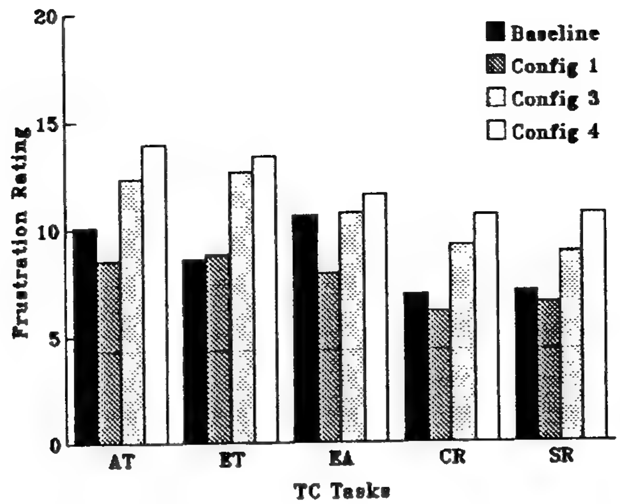

Figure 14. Tank commander mean frustration ratings for tasks by configuration. AT = acquire targets; ET = engage targets; EA = evade ATGMs; CR = prepare/send CONTACT reports; SR = prepare/send SPOT reports.

Generally, tasks associated with gunnery performance (i.e., acquire targets) and defensive performance (i.e., evade ATGMs) had significantly higher workload associated with them than comparable workload for reporting tasks (i.e., preparing and sending CONTACT and SPOT reports). There was a positive trend indicated for higher workload ratings associated with each successive VIDS configuration. Of the six types of task loadings for workload, Frustration tended to account for the largest relative increase for tasks and appeared to load higher on VIDS configurations 3 and 4. Increased frustration (stress) was thought to be related to TC loss of control, especially when automated smoke deployment or counterfire occurred. TCs apparently perceived more loss of control in VIDS configurations 3 and 4 than in configuration 1.

Sub-issue c: How Does the VIDS Interface Affect Equipment Usage?

RA ratings of frequency of visual equipment usage has been previously used in ARI sponsored research (Leibrecht et al, 1992; Leibrecht et al, 1993) to discern patterns of usage that may be helpful in assisting future system designers and training developers. The CCDP, which provided direction and bearing to threats, was thought to be an asset for assisting the TC in understanding the battlefield situation. In this evaluation, a TC could use his vision blocks, his gunner's primary sight extension (GPSE) for the baseline configuration and, additionally, his CCDP for VIDS configurations. It was unknown as to how much time a TC might devote to any of the visual equipment in the different configurations.

Table 42 provides the mean RA ratings for each configuration. As shown, the TC usage was split about 65% and 35% between vision blocks and GPSE, respectively. This makes sense in that the TC would spend more time scanning for enemy through vision blocks which gave him a wider range of battlefield view. He would use his GPSE to identify targets and conduct maneuver (with the azimuth indicator displayed in the sight). As the VIDS CCDP was added, the TCs spent about 15% to 17% of their time using the CCDP. There was a very slight increase in usage as each successive VIDS configuration was employed with a corresponding slight decrease in GPSE usage. In comparison to baseline configuration usage, the overall VIDS usage indicated TCs spent 6.3% less time on vision blocks and 9.85% less time on the GPSE to use the CCDP. TCs spent relatively less time using the GPSE in favor of using the VIDS CCDP. Possibly, they could use the CCDP's "birds-eye" view of their threat alert sector and their threat information fields to obtain information about enemy type and location.

Table 42

Mean Ratings of Tank Commander's Visual Equipment Usage by Configuration

	Percent Visual Equipment Usage		
Configuration	Vision Blocks	GPSE	CCDP
Baseline	65.47	34.53	N/A
1	58.24	26.13	15.64
3	59.17	24.83	16.00
4	59.93	23.09	16.90
VIDS Overall	59.11	23.09	16.18

Note. N = 16. GPSE = Gunner's Primary Sight Extension; CCDP = Commander's Controls and Display Panel; VIDS = Vehicle Integrated Defense System.

Because the focus of this evaluation was also on platoon-level performance, the differential distribution of visual equipment usage by platoon elements was examined. Table 43 displays the mean ratings of equipment usage by platoon element position. The Plt Ldr and Plt Sgt are the two leadership elements in the platoon and constitute the focus of this examination. The Plt Ldr spent about 20% more time using vision blocks, over 8% less time using the GPSE, and over 11% less time using the CCDP than the Plt Sgt. Possibly, the Plt Ldr spent more time using vision blocks to command and control his platoon. It was interesting that the Plt Ldr spent less time on the CCDP given its capability to provide additional battlefield information. Possibly, the Plt Ldr did not see the tactical value in using the information from the CCDP but simply used it as a reference for enemy awareness. RA observations about Plt Ldrs indicated that as the Plt Ldr became more familiar with the system, he relied on audible warnings to alert him to look at the CCDP.

The Plt Sgt spent more time using his GPSE and CCDP. During scenario execution, it was evident from monitoring radio transmissions that the Plt Sgt was often providing navigation-related information, indirect fire information, and enemy location information to the Plt Ldr. Given this observation, it was possible that the Plt Sgt spent more time tracking the overall battlefield situation than the Plt Ldr. It was interesting to note that the Plt Sgt's wingman spent relatively little time using the CCDP and more time using the vision blocks. (Possibly, the wingman was maintaining immediate vicinity monitoring to assist the Plt Sgt during maneuver and direct fire operations.) It was possible that the differential usage between the Plt Ldr and Plt Sgt was due to prior platoon command experience; Plt Sgts had more experience than the Plt Ldrs. Possibly, CCDP usage by the Plt Ldr could be influenced by providing more training in the tactical use of the CCDP. Also, it may be that a division of labor for use of VIDS within the platoon might be appropriate. SOPs might be modified to distinguish which platoon element would take the responsibility for monitoring sensor information from the VIDS.

In summary, the differential usage data suggest several possible impacts from introducing the VIDS interface into the TCs crewstation. The CCDP could be used by the TC to supplement their ability to locate

Table 43

Mean Ratings of Tank Commander's Visual Equipment Usage by Position

	Percent Visual Equipment Usage		
Position	Vision Blocks	GPSE	CCDP
Platoon Leader	60.16	28.23	11.61
Platoon Sergeant	40.36	36.56	23.07
Platoon Wingman	60.50	29.07	10.43
Platoon Wingman	73.77	22.73	3.50
Overall	58.70	26.07	12.15

Note. N = 16. GPSE = Gunner's Primary Sight Extension; CCDP = Commander's Controls and Display Panel.

and identify threats with conventional use of the vision blocks and GPSE. Platoon elements, especially Plt Ldrs, would probably benefit from training on the tactical use of the CCDP. Also, procedures for differential usage of the CCDP might be developed and incorporated into platoon SOPs. For example, Plt Sgts might be given the responsibility for monitoring and tracking the battlefield through his CCDP and sending other element reports to provide the Plt Ldr with information for tactical decisions and platoon actions.

Sub-issue d: What Are the Soldier-Participant Comments for Improving the VIDS Design?

This final SMI sub-issue was addressed by examining open-ended comments made by soldier-participants on specific items on their SMI evaluation questionnaire and to prompted questions during their final debriefing. The listing of comments from both sources were reviewed to identify suggestions either having merit in regard to improving the VIDS system or having been frequently suggested by different participants.

Table 44 identifies suggestions for improving the VIDS. The suggestions were organized into six major categories: CCDP display, CCDP keys, audible tone alerts, voice message alerts, countermeasures, and counterfire.

The soldier-participant suggestions for improvements to the VIDS design were limited to their immediate experience with the system as it was operated in this evaluation. TCs were not allowed to operate all the menus that would have allowed them to change the setup of the sensor detection sectors, safety sectors, countermeasure restrictions, counterfire restrictions, and operating modes. For example, many TCs wanted the hull reference icon to be oriented to North and rotate with the change in vehicle direction. This was an option in the setup menu but was not implemented because it still had some problems. However, the option was presently designed into the system and requires no recommended change at this time. Therefore, all suggestions were screened for comments that could have been implemented with the setup menu and only comments reflecting system improvements yet-to-be implemented were listed.

Table 44

Soldier-Participant Suggestions for Improving the VIDS

<u>CCDP display</u>
Add screen dimmer to adjust brightness.
Add indicators for range to target-grid square overlays or signal strength readout.
Allow use of touchscreen for selecting icons for deletion.
<u>CCDP keys</u>
Make hard push buttons for field model.
Use less buttons.
Change TGTSEL button to identify delete function, i.e.,TGTDEL.
SCROLL buttons should indicate direction (up or down) to select next target.
<u>Audible tone alerts</u>
Use different tones (i.e., steady versus warbling) for different threats.
Use different tones for threat ATGM actions, i.e.,detection, acquisition, launch.
<u>Voice message alerts</u>
Increase the volume of voice warnings.
Use different female voice.
Have voice tell what countermeasure is deployed.
<u>Countermeasures</u>
Have CPS distinguish between threats and friendlies.
POMALS use should be under control of Tank Commander (TC).
<u>Counterfire</u>
Change priority logic so CF distinguishes threats, i.e., live versus dead, immediate versus long-distance, and threats versus friendlies.
Separate from countermeasure logic
Put TC in the loop with an override if in automatic mode

<u>Note.</u> VIDS = Vehicle Integrated Defense System; CCDP = Commander's Controls and Display Panel; ATGM = Anti-Tank Guided Missile; CPS = Combat Protection System; POMALS = Pedestal Operated Multiple Ammunition Launch System; CF =

Several TCs complained that the screen was too bright and needed adjustment. Additionally, they pointed out that the brightness at night on a real vehicle with open hatch could be a battlefield signature giving away their position. Therefore, they recommended that there should be a setting to dim the display. Another prevalent comment related to the lack of range features on the display. Only the FASR and TRWR reported range in the Threat Coordinate Field. TCs indicated that they would like to see an overlay (like grid markings) that would have placed the threat icons in distance to the hull icon. Another suggestion mentioned that a signal strength meter might be used to indicate relative distance from a sensed threat. Unfortunately, many of the sensors had only the capability to determine relative direction and no capability to determine range. An improvement might be to fuse sensor information from different sources to determine some relative direction and distance then depict their location (via icon) on the CCDP screen graphically to provide the needed information. Some TCs felt the touchscreen would be useful for selecting icons directly for information and/or target deletion.

Several TCs thought that the fixed function keys and programmable function keys should be actual push

buttons. Most TCs realized touch screen sensitive buttons were used for quickly changing the VIDS configuration keys but they expressed the desire that on the real tank, the keys should be push buttons to prevent accidental pushes and assist operations when wearing gloves. Specific changes were suggested for two fixed function keys: TGTSEL and SCROLL keys. The TGTSEL key was for selecting an icon for deletion from the threat queue. TCs thought the label was misleading and should reflect the delete function, hence TGTDEL. TCs also felt the SCROLL UP or SCROLL DOWN button should highlight for the direction the next priority threat was located. (However, in most cases the direction would be down.) Additionally, several TCs thought there were too many buttons. Possibly, they thought the buttons were serving as signals for countermeasure operation because they were not allowed to operate them manually.

Audible tones keyed the TCs to look at their screens when a threat was detected. This was a useful feature in that it allowed the TC to use his vision blocks and GPSE until an alert sounded. Some TCs felt important threat information could be conveyed audibly by changing the alert tone according to the threat encountered. Although one TC suggested a steady versus warbling tone, he did not indicate how the tones should be associated with a particular threat. Several TCs indicated changing tones associated with threat platforms using ATGMs. For example, they thought the detection, acquisition, and launch actions could be differentiated by the VIDS sensors. However, this change might only be effective for the TRWR sensor which gives that information textually in the Threat Coordinate Field.

Other suggestions for improving audible alerts were changing the voice messages. Several TCs remarked that the voice message for helicopter detections and identifications needed to be louder to be heard over the crew intercom. Additionally, they liked the female voice in that it helped distinguish the voice from the other crewmembers' voices but they felt it should be more "feminine." Several TCs remarked the voice was too low in pitch and did not sound different from other crewmembers' voices. Another suggestion was to have the voice announce what countermeasure was being deployed. Sometimes CMs were deployed so quickly, the TC never had the chance to visually spot the highlighted CM before it finished deploying.

Specific comments were directed at two countermeasures that could have repercussions for platoon elements. First, several TCs indicated they thought CPS might blind one of their own friendly elements because they had no control over its orientation to the threat. Their concern was that the CPS was so effective and reacted so quickly that it could blind friendlies that were within its arc of deployment. Thus, they recommended it should have a feature to distinguish between friendlies and threats before deploying. (Obviously they were not wrong in their assumptions, given there were some CPS fratricides as seen in the performance data.) Additionally, some soldiers felt that the enemy might be able to use a laser warning receiver to locate friendly forces using CPS. Second, several TCs felt that the POMALS should still be under their control. Several times the POMALS flooded the battlefield with smoke and made it extremely difficult to maneuver and acquire targets. If the TCs had a representation of where the POMALS would deploy prior to deployment, then placing the POMALS in manual mode could allow the TCs to retain control. However, they would also incur more vulnerability to enemy acquisition if this was implemented.

Counterfire recommendations were the most numerous. Many TCs disliked the counterfire feature as it was implemented in this evaluation. Counterfire was supposed to be the last response implemented in the threat resolution module logic. However, counterfire occurred all too frequently during the scenarios, especially in VIDS configurations 3 and 4. Many times the counterfire activated against friendlies, unseen threat platforms, or burning threat platforms. For this reason, some TCs suggested changing the threat priority logic to distinguish between immediate and long distance threats, dead and live threats, and threats versus friendlies. Also, some TCs suggested disconnecting the counterfire from the CM logic entirely. Also in this evaluation, counterfire was practically automatic most of the time without an override mechanism available for the TC or gunner. Often, counterfire took control of the turret away from the TCs and gunners during gunnery operations and sometimes interfered with the TC's control over maneuvering the tank. For these reasons, many TCs (and gunners) recommended deleting the counterfire as currently implemented or at a minimum, put the TC into the decision loop prior to counterfire activation. One TC, currently assigned to the M1A2 NET team, recommended that the counterfire be implemented in the Commander's Independent Thermal Viewer which slewed independently of the turret for target acquisition. Mainly, TCs

wanted the option to control the counterfire activation and know what it was activating against prior to slewing the turret. Interestingly, when platoons were given their choice of implementing the VIDS system in the way they wanted for freeplay excursions, all placed their counterfire in manual mode to prevent automatic activation.

Summary of SMI Findings

Results of the SMI portion of the evaluation issues were organized around the four SMI sub-issues. Key findings for each sub-issue are organized below.

VIDS acceptability. This sub-issue focused on how acceptable the VIDS features and functions were for the TCs. Given the TCs' limited use of the full features and functions of the VIDS for this evaluation, the TCs rated the VIDS system acceptable overall with a few exceptions. TCs rated touch screen input functions, threat priority assignment and display features, icon deletion functions, end of engagement procedures, and the main gun counterfire function as less than acceptable.

Task workload. This sub-issue was directed at assessing any task workload differences due to VIDS operations with specific tasks performed during the scenarios. Results for Plt Ldr task workload were not significant to warrant further examination. However, TC workload findings were significant for task differences, configuration differences, and task by configuration differences. Notably, no mode differences were detected. The acquisition of gunnery targets and evasion of ATGM tasks had higher workload associated with them than workload associated with the performance of preparing and sending CONTACT and SPOT reports. There was a positive tendency for each successive VIDS configuration to have increasingly higher rated workload, especially for VIDS configurations 3 and 4. Frustration appeared to account for higher workload ratings associated with tasks and with configurations 3 and 4. Frustration loadings were thought to be reflective of the stress associated with the TCs perceived loss of control during turret operations (i.e., counterfire activations), especially while operating in configurations 3 and 4.

Visual equipment usage. This sub-issue was for addressing differential equipment usage for visual equipment within the TCs workstation and for platoon position usage. TCs had the opportunity to use vision blocks, the GPSE, and the VIDS CCDP to gather battlefield information. There was a tendency for TCs to use the CCDP more at the expense of the GPSE than vision block usage. Plt Ldrs tended to use the CCDP less than the Plt Sgts. It was thought that either Plt Sgts saw more value in using the CCDP because of their relatively longer experience in platoon tactical operations, or that Plt Sgts assumed a natural platoon role for handling information from the CCDP. It was thought that tactical training in the use of the CCDP would increase CCDP usage (particularly for Plt Ldrs) and that there might be procedural divisions of labor within the platoon for CCDP responsibilities.

Suggestions for SMI design improvement. This sub-issue was directed at soliciting soldier-participant suggestions for improving the VIDS design. Several recommendations directed at improving specific components of the VIDS design were made in six areas: CCDP display, CCDP keys, audible tone alerts, voice message alerts, countermeasures, and counterfire.

Tactics, Techniques, and Procedure (TTP) Impacts

This section addresses findings associated with the fourth evaluation issue:

What is the impact of soldiers using VIDS-configured vehicles on combat platoon TTPs?

Primarily, this section focused on the use of VIDS in the combat operational environment. These findings are organized according to the dynamics of combat power outlined in FM 100-5, Operations (U.S. Department of the Army, 1993b). The discussion is based on SME (i.e., Battle Master and Co Cdr) and RA observations made during the conduct of the evaluation scenarios, soldier-participant feedback from questionnaires and the AAR, and combat operational performance results.

Due to the limitations imposed by experimental control procedures for this evaluation, TCs were not allowed to change VIDS settings or operational modes according to combat operations. This restraint greatly reduced the scope of TTP development for VIDS and tactical deployment. Additionally, the lack of observational tools in the ECC prevented detailed observations of TC performance associated with battlefield events. Therefore, the scope of this discussion about VIDS impact on TTPs and battlefield operations is limited to observed impacts on the underlying elements of combat power. All discussion is based on the soldiers use of VIDS, in general, as compared to their operations when using the baseline M1 configuration.

VIDS and Dynamics of Combat Power

Combat power is the ability to fight. The four primary elements comprising combat power are: maneuver, firepower, protection, and leadership. Maneuver is defined as the movement of combat forces to gain positional advantage to deliver or threaten to deliver direct and indirect fire. Firepower, essential to defeating the enemy's ability to fight, is the amount of fire that can be delivered by a position, unit, or weapon system. Protection refers to conserving the fighting potential of the force so that it can be applied at a decisive time and place. Protection is composed of four components: (a) deception and operational security to keep the enemy from locating the force, (b) maintaining soldier health and guarding equipment and supplies to sustain and maintain fighting morale, (c) practicing and promoting safety in all training, planning, and operational procedures to preserve combat power and ensure successful combat operations, and (d) avoiding fratricide by exerting strong command, maintaining detailed situational awareness, conducting disciplined operations, and anticipating situations in which the probability of fratricide is increased. Leadership refers to the competence and confidence of the officers and noncommissioned officers to command and inspire soldiers to win regardless of equipment. Leaders determine how maneuver, firepower, and protection will be effectively used against the enemy. This necessitates that leaders be technically and tactically competent in the use of their equipment.

VIDS impact on the four elements of combat power was differentially effective. Each impact is described below according to the element affected.

Maneuver

Platoons with VIDS-equipped tanks were able to gain better position to deliver direct fire on enemy vehicles due to their increased protection. The VIDS-equipped platoons were able to reduce the enemy's ability to engage them at longer ranges. The range data confirmed that the enemy had to get closer to effectively engage the VIDS-equipped platoons, which meant giving up positional advantage and exposing themselves to the platoon's fire. Conversely, the VIDS-equipped platoons were able to locate the enemy vehicles quicker and successfully engage them at longer ranges indicating a positional advantage for them over that of their enemy. Additionally, VIDS-equipped platoons were able to maintain unit integrity during maneuver, according to soldier comments. Several wingmen mentioned the advantage of using the FASR to maintain contact with the rest of the platoon as they continued cross country maneuver to objectives. Other aspects of maneuver such as movement techniques and navigation were not explored in this evaluation.

Firepower

VIDS increased the overall firepower in a couple of ways. As mentioned in discussion of VIDS impact on the maneuver element, platoons with VIDS-equipped vehicles effectively increased their ability to successfully acquire and engage the enemy quicker and at longer distance than the enemy could engage them. TCs frequently commented that the VIDS long range sensors such as FASR and NIS, in conjunction with the CCDP, helped them locate and acquire targets early. The most common explanation was that the icons displayed the approximate position of the enemy in relation to the vehicle hull. The TC was then able to use this information to lay the main gun in the approximate direction of the enemy, thus allowing the crewmembers to use vehicle optics to acquire and identify enemy targets.

Another advantage of VIDS in relation to firepower was the degree to which the enemy was unable to

take advantage of meeting engagements, ambushes, and defensive fire. Platoons using VIDS-equipped vehicles survived longer on the battlefield once engagements started. This meant the advantages traditionally associated with firing from concealed positions and the advantage of the element of surprise were denied to the enemy. Because VIDS-equipped platoons were able to survive the first rounds fired, they often reversed the enemy's advantage and used the speed and firepower of the M1 Abrams to rapidly acquire, engage, and destroy many enemy vehicles before taking their first hit on any platoon element.

Protection

VIDS had several positive impacts on force protection. The data clearly demonstrated that VIDS equipped vehicles were engaged, hit, and killed significantly less often by enemy main gun fire. Additionally, VIDS-equipped vehicles sustained fewer engagements and hits from short- and long-range ground-launched ATGMs and air-launched ATGMs. Much of this increased survivability was due to the protective countermeasures deployed by the system upon sensing threats. Of the available countermeasures used in VIDS configurations, CPS was the overwhelming choice of TCs. One reason for this preference was that CPS attacked enemy platforms rather than munitions fired from the platforms. They also preferred CPS because it interfered less with normal functions of their own tank whereas countermeasures such as POMALS deployed smoke or counterfire automatically slewed their main gun.

Although no data were available for the direct measurement of the advantages of VIDS sensors to assist force protection, soldiers commented on the capability of the NIS to provide early warning of enemy aircraft, an air defense capability. From RA observations and soldier comments, the NIS apparently keyed the crews to focus their attention on aerial threats. Soldier comments made during AARs indicated this was a good sensor to have, but that sometimes it was distracting when the enemy aircraft was not the immediate priority. One technique mentioned was to designate one platoon element to track and maintain gun tube orientation toward the threat.

One component of protection is the avoidance of fratricide. Unfortunately, platoons using VIDS-equipped vehicles had a noted increased probability for committing fratricide. The data indicated an increased number of possible fratricide engagements and an increased number of fratricide hits, especially for the VIDS configurations with more sensors and countermeasures, i.e.,configurations 3 and 4. Several soldiers expressed the opinion that some sensors, such as the muzzle flash detector, caused automated counterfire to slew their gun tube onto other platoon elements. There were also a number of CPS fratricide engagements noted. The fratricide data indicated that there is a need for safeguards to prevent the occurrence of future fratricide. The most frequent soldier comment was the need to include sector-of-fire limits on force protection systems to reduce the chance of mishaps between vehicles using automatic countermeasures. (Sector limits were available in the VIDS software but were not utilized during this evaluation.) Another recommendation was for the system to employ an interrogation and response system to differentiate between friendly and enemy vehicles prior to deploying lethal countermeasures. As for future theaters of war wherein friendly and enemy are using the same rotary aircraft, several soldiers recommended that acoustic signatures of friendly aircraft be altered to allow the NIS sensor to detect the difference between friendly and enemy rotor noises.

Other components of the protection dynamic were not examined or possible in this evaluation. Deception and operational security were not examined. The capability to conduct mobility and countermobility operations were not available in this simulation. The OPFOR was not capable of exploiting any of the platoons weaknesses to further stress the protection capabilities.

Leadership

The CCDP provided the Plt Ldr with an additional tool to visualize the battlefield by showing his relation to detected threats. Additionally, the sensor cues and warnings triggered in individual vehicles tended to increase the platoon cross talk about threats and battlefield information. Together, this information provided the Plt Ldr with more information than normally associated with baseline M1

operations. The additional information should have contributed to the Plt Ldr's capability to lead his platoon effectively.

Technical and tactical competency was a factor in the leadership and use of the VIDS to enhance the other dynamic elements of combat power. In this evaluation, much of the interaction between the TCs and the VIDS occurred at the CCDP. The ability to make use of the information on the display was largely dependent upon the individual TCs. Throughout the evaluation, RAs witnessed situations where the TCs failed to take advantage of the information made available to them on the display. The RAs offered several observations as to why the TCs failed to use the CCDP to their advantage. They observed that sometimes TCs became reliant on the VIDS to protect them and ignored the tactical information on the CCDP entirely. Also, they felt TCs failed to realize the value of the information displayed. Additionally, they observed that TCs became so frustrated with the system that it affected their use of the CCDP. These comments correspond with the equipment usage and workload data mentioned previously. It was noted that the younger and inexperienced Plt Ldrs and TCs did not use the CCDP as much as the older, more experienced Plt Sgts. This suggests that the more inexperienced leaders missed the tactical potential of using the CCDP. Confirming the frustration level observed by the RAs, the workload data indicated high frustration levels associated with the VIDS usage, especially in the VIDS configurations where the automated countermeasures and counterfire were often triggered.

Despite these shortcomings, the TCs did recognize the increased enemy awareness made possible by the sensors and display. Several TCs made comments during AARs indicating that the extra awareness would improve their ability to perceive changes in their battle environment and anticipate actions needed to take advantage of the situation. However, they felt that the constraints of the scenarios sometimes limited their ability to take advantage of this enhanced awareness.

Recommendations for improving leadership and the other dynamics of combat power include training and design improvements. As mentioned in the training and SMI findings, individual and crew integration training and drills needs to be developed to train the TCs and crews in the tactical use of the sensor information and countermeasure deployment. VIDS and CCDP design improvements were mentioned as possibilities to enhance the leadership and battle command capabilities of the VIDS. SMEs thought that a display with the capability like the Inter-Vehicular Information System (IVIS) (Du Bois and Smith, 1991) to digitally communicate with other platoon elements would be useful. Integrating VIDS with a digital communication system and global positioning system would enhance the leaders' ability for battle command. Such a system would allow the platoon platforms to be digitally linked and identified with other platforms. This linkage would allow them to see the relative position of friendly elements versus sensed threats which should enhance their battlefield awareness. Additionally, a digital system would shorten the time needed for a sensing vehicle to transmit critical battlefield intelligence. Possibly, automated sensing reports like CONTACT reports with predetermined addresses (i.e., to the Plt Ldr and higher) could be used to decrease the TC workload and time to send reports.

Summary

The VIDS enhanced the combat power of the platoon. VIDS-equipped platoons were able to gain positional advantage over the enemy and maintain unit integrity during maneuver. Firepower was increased due to enhanced detection and location capabilities of VIDS sensors. Additionally, VIDS-equipped platoons were able to reverse the enemy's firepower advantage by using the automated countermeasures to survive the initial engagements, quickly counterattack, and use their firepower to destroy the enemy. Countermeasures on VIDS-equipped vehicles provided significant protection against enemy weapons platforms firing main gun and ATGMs. Additionally, VIDS long range sensors, like NIS, alerted the platoon to hostile weapons platforms early which gave them the opportunity to prepare for offensive action prior to visually acquiring the platform. Unfortunately, VIDS-equipped platoons often had more incidents of fratricide despite their better sensor awareness and vehicle protective systems. Although platoon leadership elements recognized the potential of the VIDS CCDP to enhance battlefield awareness and command, they often failed to take advantage of the displayed information. The VIDS could enhance the combat power of the platoon if the

leadership elements and their crews were properly trained in its tactical use and if the system was improved with IVIS-like enhancements.

EVALUATION LIMITATIONS AND IMPLICATIONS

There were several limitations stemming from the software implementation, available simulation technology, design choice, and implementation procedures that had an impact on the evaluation results and their interpretation. These limitations are listed and described below:

1. The software implementation for the VIDS and its interaction in the simulated environment was not functionally defined and complete at the beginning of the evaluation. Notably, the semi-automatic mode became automatic mode after its initial use in an engagement, the threat resolution module response was not always consistent for simultaneous threat events, counterfire actions were frequent and incapable of being overridden, and calculation of vehicle intervisibility for purposes of measurement was not possible.

2. The simulator's limited fidelity of M1 functions constrained the capability of crews to operate realistically in gunnery procedures and may have influenced lethality results. Sometimes the CIGS for sights and vision blocks could not keep pace with real time events happening in the simulation. Crews experienced unsteady graphics, bluing of sights, and short term loss of visual ability (during smoke) which hampered maneuver and target acquisition. The lack of TIS hampered the ability of the platoon to realistically engage targets when smoke was deployed.

3. The lethality results may have been influenced by the type of simulation used in the MWTB. The MWTB is primarily a maneuver and command and control simulation. The gunnery simulation algorithms in the MWTB wee not designed specifically for gunnery operations such as those found in the Conduct of Fire Trainers (COFTs).

4. The MWTB simulation limitations may have affected operational realism. The inability of open hatch operations constrained the TC in his ability to maneuver and navigate on the battlefield and made it extremely difficult for the platoon leader to set up defensive battle positions. Additionally, results and interpretations were constrained due to the limited fidelity of the simulated battlefield environment. These limitations include a zero-motion platform, lack of dynamic terrain, limited battlefield sounds, and absence of weather variations and atmospheric degradations. The VIDS sensors and countermeasures in the real world might have been affected dramatically under less than perfect weather conditions which in turn would affect operational effectiveness.

5. Unrealistic behavior of the OPFOR may have affected operational realism. OPFOR vehicles always had perfect identification of targets, near perfect fire control and distribution, limited maneuver capability, and absence of electronic signatures and countermeasures. Once optically blinded by CPS, the OPFOR continued its maneuver in a straight path and did not return fire which may not have realistically modeled the effects of CPS.

6. The "kill suppress" feature invoked for manned vehicles in this evaluation may have influenced individual crew member's behaviors during tactical operations, i.e., evading ATGMs by using turret defilade in defense or performing "sagger dance" maneuvers. Also, since OPFOR vehicles tended to target the same vehicles several times, it was unknown at what point the platoon would have been unable to continue its mission or engagement due to losses.

7. Soldier-participants behavior may have had an impact on results and their generalizability to actual combat. Unlike actual combat situations, soldiers in the evaluation were often well rested. Soldiers performance may have been influenced by the multiple repetition of the same three scenarios, i.e., boredom. In addition, operational realism was to an extent dependent on the role playing behavior of participants. Motivational procedures to inspire realistic role playing were used, but their effectiveness on soldiers actions

were unknown.

8. Design methodology and lack of observational tools in the ECC prevented detailed examination for TTP development. Due to the standardized control of automatic and semi-automatic mode for all sensors and CMs and rigid setup controls, soldiers were not allowed to make choices about VIDS operations in offensive and defensive situations. Although the strict control was needed for experimental design, it did not allow soldiers the chance to develop alternative setups or preferred operations in tactical situations which would have yielded greater insights into TTP development for the VIDS. Additionally, the ECC did not have displays for observing turret operations, displays of CCDP operations, and PVD options for monitoring the different countermeasure effects.

It is worth noting that many of the limitations applied equally across the different configuration conditions and should not have influenced performance conditions unequally or to the advantage of the experimental treatment conditions. As with previous experimental evaluations conducted in the BDS-D environment, these limitations constrain the generality of results of this evaluation. Therefore, the reader should exercise caution in applying these results to other environments (such as actual combat) and in using the results in other simulation efforts, i.e., modelling.

SUMMARY AND RECOMMENDATIONS

This last section summarizes the findings of the VIDS evaluation related to operational effectiveness, and provides recommendations for future training, VIDS design, and methodology for future evaluations.

Operational Effectiveness

Table 45 organizes and presents summarized conclusions about the relative VIDS impact on operational effectiveness as compared to baseline M1 performance. Additional findings about optimal VIDS configurations are included. Combat operational effectiveness for this evaluation was focused on battlefield survivability and lethality. The reader should remember that these findings are based on the performance of tank platoons operating in the BDS-D environment. Also, these findings need to be considered within the context of the evaluation limitations cited in this report.

Recommendations for Future Training

The training issues relevant to this evaluation were related to current training program assessment and improvements and future training requirements assessment. Although the current training program was adequate for training the soldiers to perform within the constraints of this evaluation, there were several improvements that could be made to training for future evaluations. Table 46 presents the recommendations for improving the current training program. The other main training concern for this evaluation was to identify future training requirements. Based on those requirements, summarized recommendations are provided for future VIDS new equipment training in Table 47. Given the fact that soldier-participants were not allowed to program the VIDS functions other than setting operational mode, both current training programs and future new equipment training could be greatly increased in length and complexity.

Recommendations for VIDS Design Improvement

The SMI issues investigated for this evaluation focused on identifying user acceptability, associated task workload, differential VIDS usage, and VIDS potential problems and design changes. Information from all four areas of investigation were used to derive recommended changes to the existing VIDS design. Table 48 lists the recommendations by VIDS feature or function.

Table 45

Summary of Findings for VIDS Combat Operational Effectiveness: Battlefield Survivability and Lethality Performance

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Survivability

VIDS platoons were engaged, hit, and killed significantly less often.

VIDS platoons significantly reduced the enemy's standoff range.

VIDS platoons significantly sustained fewer engagements and hits from ATGMs.

VIDS platoons had an increased tendency to commit fratricide.

For VIDS comparisons only, configuration 4 was better than 3; both better than configuration 1.

Lethality

Once engagements started, VIDS platoons survived significantly longer on the battlefield and destroyed more enemy before receiving their first hit.

VIDS platoons contacted the enemy quicker, at greater ranges, and destroyed them in less time.

No optimal VIDS configuration was identified.

Note. VIDS = Vehicle Integrated Defense System; ATGMs = Anti-Tank Guided Missiles.

Recommendations for Future Evaluations

The experience and lessons learned during the preparation and execution of this evaluation provide valuable insights for future force protection evaluations. Recommendations pertaining to evaluation preparation, methodology, and simulation and simulator improvements are presented in the following paragraphs.

Evaluation Preparation

Recommendations based on lessons learned during preparations conducted prior to the experimental evaluation are as follows:

1. Prior to conducting evaluations, functional testing of software and hardware is conducted. Functional testing of software and hardware is performed to finalize the concept system implementation into the simulation and simulator. Functional testing should be scheduled with time allowed for refinements. Software refinements should be halted (frozen) prior to ending functional testing. Functional testing should also include evaluation of planned measurement procedures to ensure software will properly interact with the existing simulation and data capture routines to yield proper data for planned measures.

2. Pilot testing is performed to evaluate training and evaluation materials and procedures prior toconducting evaluations. Ample time should be scheduled between functional testing and pilot testing for developing credible work around procedures for system shortfalls. Additionally, a minimum of two weeks should be scheduled between pilot testing and evaluation start to allow enough time to fully evaluate and fix training and evaluation materials and procedures.

Table 46

Recommendations for Existing VIDS Training Program

Maintain the basic training program structure.
Review and eliminate redundancies in classroom training time.
Develop outlines of scripted briefings for handouts.
Increase VIDS hands-on instruction and practice time in training threat icon symbology, icon deletion functions, using operational modes, and performing counterfire operations.
Lengthen collective training time in exercises. Provide more crew training with VIDS operations. Include more training time in platoon navigating techniques and procedures.
Develop a canned interactive large screen demonstration for illustrating CCDP operations.
Add a directed roundtable discussion for crews and platoons.
Develop the planned embedded CCDP training functions to enhance hands-on instruction. Perform RA hands-on training, diagnostic testing, and remedial training exercises in stand-alone simulators.
Develop tactical training with CCDP usage to enhance Plt Ldr and TC operational effectiveness.
Provide platoon STX feedback with playback functions and large screen Stealth.

Note. VIDS = Vehicle Integrated Defense System; CCDP = Commander's Controls and Display Panel; RA = Research Assistant; Plt Ldr = Platoon Leader; TC Tank Commander; STX = Situational Training Exercise.

Table 47

Recommendations for VIDS New Equipment Training

Schedule about 5 1/3 POI hr for training individual VIDS operations such as identifying and locating threats, determining threat priorities, and countering threats and threat munitions. Plan to perform individual training in the simulator.
Schedule 4 1/3 POI hr for training the integration of VIDS into crew operations. Plan training for both simulator and real tank.
Schedule 2 1/5 POI hr for training integration of CCDP information into battlefield reporting. Plan training for both simulator and real tank.
Schedule 2 2/5 POI hr for training VIDS integration into platoon tactical maneuver. Plan training for both simulator followed by platoon training in the field.

Note. POI = Program of Instruction; VIDS = Vehicle Integrated Defense System; CCDP = Commander's Controls and Display Panel.

Table 48

Recommendations for VIDS Design Improvements

Commander's controls and display panel
Add screen dimmer control.
Add range indicators to display.
Change TGTSEL key to TGTDEL (if continued use is for icon deletion).
Add next priority threat direction indicator for SCROLL keys.
Investigate adapting standard recognizable icon symbology, i.e.,NATO standards.
Add touchscreen selection of icon capability.
Investigate integrating an IVIS-like digital interface.
Audible alert systems
Adapt usage of different tones for different threats and enemy actions.
Add volume and tone control for voice messages.
Expand voice message use for warnings and VIDS actions, i.e.,CM responses.
Commander's control handle
Add a counterfire override feature.
Operational modes
Further define and develop semi-automatic mode functionality.
VIDS threat resolution module
Improve logic to determine nearest and most dangerous threat.
Improve logic for handling multiple and simultaneous threats.
Simplify end-of-engagement procedures for semi-automatic operations.
Develop counterfire logic to place soldier-in-the-loop for engagement decision.

Note. NATO = North Atlantic Treaty Organization; IVIS = Inter-Vehicular Information System; CM = Countermeasure; VIDS = Vehicle Integrated Defense System.

Methodology

Recommendations for improving evaluation methodology and procedures are as follows:

1. Employ within subject and repeated measure designs to enhance statistical power for evaluations planned with small sample sizes. Because these designs are prone to have carryover effects, proper counterbalancing procedures should be used.

2. Design the experiment so as few experimental variables are examined as possible. Too many independent variables reduce statistical power with small sample sizes. Some variables, like the Scenario variable used in this design, should have multiple iterations to prevent carryover effects, i.e.,learning.

3. Ensure MWTB standard library of routines (if using) are able to be incorporated with any new system software added to the simulation. A whole host of measures centered around vehicle intervisibility were not able to be implemented during this evaluation.

4. Conduct on-line or real-time data analysis during functional testing and pilot testing to ensure reliable data are being collected prior to starting the evaluation.

5. Using kill suppress features may not always be a desirable option for all evaluations. Consider the effects of using the kill suppress feature for evaluation execution and outcomes. Crews may become more aggressive than usual on a simulated battlefield in which they know they are invulnerable. Special discussion sessions for stressing the importance of proper role playing should be incorporated into evaluation execution procedures. Kill suppress usage and its effects on data should be considered during initial planning of the evaluation.

6. Ensure TTP development is considered in future force development designs. Design performance measures that compliment exploration of TTPs. Additionally, consider adding doctrine developers to future evaluation teams to provide TTP guidance and training expertise for tactical employment of a force protection system.

Simulation/Simulator Improvements

Recommendations for improving the simulation and simulator are included to denote much needed changes before attempting future force protection evaluations. These are:

1. If smoke is to be implemented in the simulation, TISs need to be incorporated in the simulator to mimic real world advantages. Smoke on the battlefield without the capability to see through it has serious effects on lethality performance.

2. Faster processing power is needed in the computer image generators for real time updates of battlefield images as seen through vision blocks and sights, especially when smoke is deployed. Additionally, faster processing speed is needed for the VIDS system to enable fast updates for the CCDP and threat resolution logic.

3. Displays for observing and recording CCDP operations need to be incorporated to correlate usage with significant battlefield events. Additionally, tools for the PVD operators and Stealth operators need to be provided that allow control personnel to observe effects of countermeasures on enemy operations. These tools and visual effects need to be simulated on the displays to assist SMEs in developing TTPs and providing tactical assessments.

4. Proper modelling of the effects of countermeasures on OPFOR behavior needs to be incorporated to provide a realistic battlefield for soldier-participants. Effects of directed energy weapons especially need to be considered and modelled.

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Appendix A

Acronym List

AAR .... After Action Review
ALC .... Advanced Land Combat
AMC .... Army Material Command
ANOVA .... Analysis of Variance
ARPA .... Advanced Research Projects Agency
ASM .... Armored Systems Modernization
AT .... Anti-Tank
ATD .... Advanced Technology Demonstration
ATGM .... Anti-Tank Guided Missile

BBN .... Bolt, Beranek, and Newman Systems and Technologies Corporation
BDM .... BDM Federal, Inc.
BDRM .... Soviet Armored Reconnaissance Scout Vehicle
BDS-D .... Battlefield Distributed Simulation - Developmental
BFV .... Bradley Fighting Vehicle
BLUFOR .... Blue Force (Friendly Force)

CCDP .... Commander's Controls and Display Panel
CCH .... Commander's Control Handle
CCTB .... Close Combat Testbed
CF .... Counterfire
CIG .... Computer Image Generator
CM .... Countermeasure
Co Cdr .... Company Commander
COFT .... Conduct of Fire Trainer
CP .... Check Point
CPS .... Combat Protection System

DCA .... Data Collection and Analysis System
DCD .... Directorate of Combat Developments
DDR&E .... Director of Defense Research and Engineering
DIS .... Distributed Interactive Simulation

ECC .... Evaluation Control Center
EO .... Electro-Optical
EW .... Electronic Warfare

FASR .... Future Armor System Radar
FFK .... Fixed Function Key
FRAGO .... Fragmentary Order

GAS .... Gunner's Auxiliary Sight
GPS .... Global Positioning System
GPSE .... Gunner's Primary Sight Extension

HIND .... Soviet attack helicopter

IR .... Infra-Red
IVIS .... Inter-Vehicular Information System

LBR .... Laser Beam Rider
LC .... Line of Contact
LCMD .... Laser Countermeasure Device

LD	Line of Departure
LDES	Laser Designator
LRF	Laser Range Finder
LWR	Laser Warning Receiver
MANOVA	Multivariate Analysis of Variance
MCC	Management, Command and Control
MCD	Missile Countermeasure Device
MFD	Muzzle Flash Detector
MSGL	Multi-Salvo Grenade Launcher
MWBL	Mounted Warfighting Battle Lab
MWS	Missile Warning System
MWTB	Mounted Warfare Testbed
NASA-TLX	National Aeronautics and Space Administrations's Task Load Index
NATO	North Atlantic Treaty Organization
NETT	New Equipment Training Team
NIS	Non-Imaging System
OPFOR	Opposing Force
OPORD	Operations Order
PEO-ASM	Program Executive Office for Armored System Modernization
PFK	Programmable Function Key
PL	Phase Line
Plt Ldr	Platoon Leader
PM	Program Manager
POMALS	Pedestal Operated Multi-Ammunition Launching System
POI	Program Of Instruction
PVD	Plan View Display
RA	Research Assistant
REDCON	Readiness Condition
RF	Radio Frequency
S&T	Science and Technology
SAFOR	Semi-Automated Forces
SCC	SIMNET Control Console
Sgt	Sergeant
SIMNET-D	Simulation Network - Developmental
SINCGARS	Single Channel Ground-to-Air Radio System
SME	Subject Matter Expert
SMI	Soldier-Machine Interface
STX	Situational Training Exercise
T-80	Soviet main battle tank
TARDEC	Tank Automotive Research, Development, and Engineering Center
TC	Tank Commander
TGTDEL	Target Delete
TGTSEL	Target Select
TLD	Top-Level Demonstration
TRADOC	Training and Doctrine Command
TRM	Threat Resolution Module
TRWR	Tank Radar Warning Receiver

TTPs .... Tactics, Techniques, and Procedures

VBs .... Vision Blocks

WS .... Work Station

Appendix B

Selected Biographical Data

Table B-1

Participant's Age (in Years)

PL	TC	Gunner	Driver
26.75 (2.06) N=4	33.25 (3.28) N=12	25.94 (2.84) N=16	24.25 (3.89) N=16

Note. Each data cell includes the mean, standard deviation (in parenthesis), and number of respondents (N). PL = Platoon Leader; TC = Tank Commander.

Table B-2

Participant's Experience (in Years) by Position

	PL	TC	Gunner	Driver
Active duty	1.79 (.55) N=4	14.41 (2.90) N=12	7.11 (2.66) N=16	3.52 (1.04) N=16
In armor units	2.65 (1.40) N=4	8.95 (3.47) N=12	6.73 (2.43) N=16	3.10 (1.10) N=16
In M1 units	1.75 (1.59) N=4	6.28 (2.56) N=12	5.53 (2.22) N=16	2.84 (.94) N=16
In M60 units	0.0 0.0 N=4	4.16 (1.98) N=12	1.0 (1.65) N=16	.13 (.32) N=16

Note. Each data cell includes the mean, standard deviation (in parenthesis), and number of respondents (N). PL = Platoon Leader; TC = Tank Commander.

Table B-3

Frequency Distribution of Particpant's Education by Position

	PL	TC	Gunner	Driver
High school degree	-	2	8	11
Some college	-	8	8	5
College degree	4	2	0	0
Post-graduate work	0	0	0	0

Note. Total number of particpants is 48: 4 PLs, 12 TCs, 16 Gunners, and 16 Drivers. Platoon Leader; TC = Tank Commander.

Table B-4

Frequency Distribution of Particpant's Prior Computer Experience by Position

	PL	TC	Gunner	Driver
No experience	-	2	8	11
Little experience	-	8	8	5
Moderate experience	4	2	0	0
Considerable experience	0	0	0	0

Note. Total number of particpants is 48: 4 PLs, 12 TCs, 16 Gunners, and 16 Drivers. PL = Platoon Leader; TC = Tank Commander.

Table B-5

Particpant's Prior Maneuver Simulation Experience (in Days) by Position

	PL	TC	Gunner	Driver
Mounted Warfighting Simualtion Training Center	19.75 (7.32) N=4	48.73 (66.87) N=11	25.13 (27.91) N=16	20.06 (15.01) N=16
Mounted Warfare Testbed	5.00 (5.77) N=4	42.50 (3.23) N=12	4.06 (8.00) N=16	2.38 (5.18) N=16

Note. Each data cell includes the mean, standard deviation (in parenthesis), and number of respondents (N). One TC respondent included previous time spent in a simulation training center in Europe. PL = Platoon Leader; TC = Tank Commander.

Appendix C

Sample Training Materials

Contents of Appendix C:

VIDS CCDP Demonstration Script

NOTE TO CCDP OPERATOR: Ensure the sim is configured for Configuration 3 before starting.

1.1 - Introduction

1. Introduction of the presenter and the CCDP operator.

2. Purpose of the following instruction:

    a. 45-minute session

    b. Allows the TCs to see the VIDS Commander's Control and Display Panel functions and operations before using it themselves.

    c. Feel free to interrupt during any portion of the demo to ask questions or to see a function and operation repeated.

1.2 - Training Overview and Objectives

1. In this part of VIDS training you will focus on the basic characteristics of the Commander's Control and Display, its functions and features.

2. By the end of this training you should:

    a. Understand the VIDS display functions.

    b. Be familiar with the various screen text and data fields.

    c. Understand the graphical displays such as sectors and areas.

d. Be able to identify the various threat icons that can be displayed.

e. Understand the components of the VIDS own vehicle icon.

f. Understand the NORM Programmable Function Keys, submenus, and their operations.

1.3 - Tactical Display Touchscreen

1. The touch sensitive display will show this picture after you have turned on vehicle and turret power in the simulator. It will change to the display you will use with keys labelled to represent your particular VIDS configuration of sensors and CMs.

2. All the keys displayed around the edge of the screen can be activated by touching and then lifting your finger from the screen. When you touch a key it will highlight, indicating it is activated. For purposes of this demo, the Commander's Control and Display Panel operator in the simulator will be activating the keys as I point to them on the screen.

3. Fingertips only on the screen - no pens, pencils, sharp or blunt objects, etc. should be used. These screens can be easily damaged and we have no backups.

4. I will demonstrate the touchscreen use by powering up the VIDS display by touching the **POWER** Fixed-Function Key in the upper right hand corner. By the way, note the keys marked SPARE before we turn on the system.

*(Operator touches **POWER Fixed Function Key** to power up the new display as instructor points to the key.)*

5. As you can see, the keys marked SPARE now have new labels representing the CMs available for VIDS configuration 3. You also see graphics and textual fields. We will discuss these features later after briefly reviewing the sensors and CMs available for this configuration.

<u>1.4 - VIDS Configuration 3</u>

1. In the previous instruction you received information about the sensors, countermeasures, and the four different VIDS configurations.

2. You have the following sensors and CMs available for this configuration:

   a. Laser Warning Receiver (LWR) - Detects laser ranging and designation.

   b. Missile Warning System - Detects ATGM launches.

   c. Non-Imaging Sensor - Detects and identifies helicopters.

   d. Future Armored System Radar (FASR) - Detects moving platforms.

   e. Tank Radar Warning Receiver - Detects hostile radar related weapon systems.

   f. Combat Protection System (CPS) - Disrupts optically tracked threat systems.

   g. Missile Countermeasure Device - Disrupts ATGM tracking systems.

h. Pedestal-Operated Multi-Ammunition Launch System (POMALS) - Obscures visual and IR acquisition capability.

i. Main Gun Counterfire - Positions main gun tube in direction of threat.

3. The Future Armored System Radar sensor is mapped to the third key down on the left side. On the right hand side, the POMALS key representing the Pedestal-Operated Multi-Ammunition Launch System Countermeasure is second from the top and the Missile Countermeasure Device is third from the top. The Combat Protection System and Counterfire are not shown in this display because they are internal to the system.

2.1 - Fixed Function Keys and Programmable Function Keys

1. The current display you see is the top level menu referred to as the Main menu.

2. The vertical keys on both sides of the display are called Fixed Function Keys. These keys always perform the same function when you press them.

3. The right side keys from top to bottom are:

   a. POWER key turns the VIDS system on or off.

   b. POMALS key represents the Pedestal-Operated Multi-Ammunition Launch System and highlights if a salvo of grenades is activated.

   c. MCD key represents the Missile Countermeasure Device and highlights when activated.

d. The SPARE keys are the next three keys and will have CMs mapped to them in different configurations.

e. ENTER key is used in conjunction with Programmable Function Key selections.

4. The left side Fixed Function Keys from top to bottom are:

a. Countermeasure Armed (CM ARM) key when activated will activate any highlighted CM in this menu. It will switch the CM ARM/SAFE indicator (point to top of display indicator).

b. Display (DSPLY) key declutters the screen by removing inactive threat icons from the display.

c. FASR represents the Future Armored System Radar (FASR) sensor and highlights when in use.

d. Target Select (TGTSEL) key will delete the top priority threat icon from the display. It is used manually after the threat is defeated.

e. The SCROll Down key will select the next lowest priority threat when activated.

f. The Scroll Up key will select the next highest priority threat icon when activated.

g. Main key will return you to this menu when anywhere in the sub-menus. It will preserve any setup actions already programmed.

5. The bottom keys represented by PF1 through PF5 are called programmable function keys. Their functions vary according to TC

inputs. Their functions will appear above them in the display. In this top level menu, NORM and SETUP are displayed. We will visit these functions and their sub-menus later.

2.2 - Countermeasure Status Displays

1. In the upper left hand corner of the display is an information field called CM SELECT.

   a. It will display the type and status (number of rounds of smoke, flares, or TCS expendable CMs) that will be fired. In this example, the VIS and IR grenades are available. The default salvo for each type will be four.

   b. This field also displays the other CMS and indicates if they are in standby or on. When a CM is activated, the Standby (STNDBY) indicator will highlight briefly with ON as a Countermeasure is activated.

2. The CM STORES information field is located directly below the CM SELECT field. It displays the number and type of Countermeasure expendables. In this case, you would see 16 for VIS and IR respectively.

3. The CM ARMED/SAFE Indicator is located at the top enter of the display. It indicates the armed or safe status of CMs currently selected for the configuration. When CM ARMED appears, VIDS is ready to fire. When CM SAFE appears, VIDS will not fire any selected Countermeasures.

2.3 - Mode Indicator

1. In the lower right hand area of the screen, the Mode Indicator field will appear, alerting you to the status of

selected modes of operation for Countermeasure and Counterfire selections.

2. It only appears when in the NORM menu display.

3. It displays the mode, either SEMI or AUTO, followed by CM or CF.

2.4 - User Alert Indicator

1. In the lower right hand corner, above the mode indicator area, user alerts will appear in text to warn you of mistakes during setup operations, scrolling violations, sector violations, and exhaustion of expendable Countermeasures.

2.5 - Threat Coordinate Field

1. In the upper right hand corner of the display, the Threat Coordinate field displays information about the highest priority threat (represented by a blinking icon inside the blue circle).

2. The azimuth, elevation, and sometimes the range is displayed depending on the sensor.

3. If a higher priority threat is detected, VIDS will replace this information with the newer information.

4. Information on lower priority threats can be displayed by using the SCROLL UP and DOWN keys. Priority is not associated with position of the threat icons on the display. Threat priority is determined by the system's logic program based on the sensor information it receives. Generally, lasers directed against your vehicle are high priority. For example, a laser range finder from a tank. The displayed information changes as you scroll through the threat icons and the blinking icon will

change according to the selected threat.

3.1 - Basic Display Format

1. The display is non-directional in that the top does not represent North and the bottom South. The top does represent the direction the vehicle hull is facing.

2. The hull icon is always stationary and does not rotate when the tank neutral steers. The turret line moves according to the line of sight of the turret and main gun.

2. The Alert Sector is represented by the outer blue circle. It corresponds to the amount of area currently covered by the sensors. The default setting is 360 degrees.

3. The inner red circle represents smoke grenade coverage sectors. With the Pedestal-Mounted Multi-Ammunition Launch System, this sector is no longer relevant, although the area does represent 60° of coverage that is the system default.

4. The dashed lines define the programmed turret limits for main gun scanning. But, we will not be using this function in this experiment.

6. The white space between the outer blue circle and the inner red circle represents the area in which threat icons will appear.

4.1 - Threat Icons

1. Before proceeding to the visual alerts, you should know about the VIDS audible alerts.

a. You will usually hear a three second tone when threats are first detected and as they appear on the display.

b. If helicopters are detected by the NIS sensor, you will hear a synthetic female voice announcing "Helicopter detected" and when it's identified you'll hear "Threat Helicopter."

c. If operating in semi-automatic mode, you may hear a female voice message announcing "VIDS is waiting." This message will occur after you receive a threat icon for which a countermeasure or counterfire is available and you delay pushing the VIDS activation button.

Distribute VIDS job aid handout to TCs. Have them look at threat symbology page.)

2. Now let's talk about the visual alerts. On the handout you'll see various symbols that will be combined in various ways to represent threat icons seen on the display.

3. Basically, you'll see either diamonds for enemies, circles for friendlies, U's for unknowns, and dashed lines for helicopters.

4. Also, you may see these icons combined with letters to represent some emission from the targets.

a. An "A" represents an ATGM.

b. A "B" represents a laser beam rider.

c. A "D" represents a laser designator.

d. An "R" represents a laser rangefinder.

e. An "M" represents a muzzle flash.

f. An "F" represents a FASR detection.

5.1 - NORM Function

1. The PF1 key, NORM, allows you to program the operational modes you will be using to operate the VIDS available CMs and the Counterfire function. It is also the display you will be using when employing the VIDS during combat operations. When you select NORM (*Operator presses the **PF1** key*), you see a new submenu. The new PFKs are: SCAN for PF1, Automatic for PF2, Countermeasure for PF3, and Counterfire for PF4.

2. The default operating mode is manual mode for all these functions and you will not see a mode indicator displaying the mode status. We will always be using semi-automatic or automatic mode for CM and CFIRE. We will not be using SCAN for this experiment and will ignore its function for this demonstration.

3. Selecting CM and/or CFIRE will place each one in semi-automatic mode. A mode indicator will be displayed in the lower right hand corner of the display. As an example, let's put the CM and CFIRE in semi-automatic mode of operations.

   a. First select CM (*Operator pushes **PF2** key*) and it will highlight. Next select ENTER (*Operator pushes **ENTER** FFK*). You'll notice the mode indicator appears in the lower right hand corner indicating the mode status of CM (**SEMI: CM**).

   b. Next select CFIRE (*Operator pushes **PF3** key*) and it highlights. Next select ENTER (*Operator pushes **ENTER** FFK*). You'll notice the mode indicator now contains CFIRE in addition to CM (**SEMI: CM CFIRE**).

   c. Both CM and CFIRE are in semi-automatic mode and can be initiated after a threat is detected by using the VIDS activation button on the Commander's Control Handle.

d. To return CM and CFIRE back to the original manual method you would repeat the procedure just described. *(Operator pushes PF2 and **RETURN** FFK then pushes PF3 and **RETURN** FFK.)*

4. To select CM and CFIRE for automatic mode you would perform the following sequence:

a. Select AUTO (*Operator pushes **PF4** key*), CM (*Operator pushes **PF2** key*), and selects ENTER (*Operator pushes **ENTER** FFK*). The mode indicator now indicates CM is in automatic mode (**AUTO: CM**).

b. Select AUTO (*Operator pushes **PF4** key*), CFIRE (*Operator pushes **PF3** key*), and selects ENTER (*Operator pushes **ENTER** FFK*). The mode indicator now indicates CFIRE in addition to CM is in automatic mode (**AUTO: CM CFIRE**).

c. Now the VIDS system is setup to operate in automatic mode for CMs and CFIRE. When a threat target is detected, it will automatically select the appropriate CM, counter the threat, and slew the gun tube to the direction of the threat and within the vicinity of the threat firing platform.

d. After defeating a threat either by countermeasure and/or counterfire and engagement, the threat icon will remain on the screen for up to 30 seconds.

(1) If a CM has countered the threat and it is no longer blinking, it is now a low priority threat and can be deleted by either waiting 30 seconds or by scrolling down using the SCROOL DOWN FFK until it blinks. Once it blinks, you can push the TGT SEL FFK to delete it. You can scroll back up to

the highest priority threat by using the SCROOL UP FFK until you reach the highest threat priority or get a user alert telling you that you have gone too far.

(2) If you have just engaged and defeated the threat platform that fired the high priority threat munition, you must signal VIDS that the engagement is finished by pushing TGT SEL to delete the icon. When the icon is deleted, VIDS knows the engagement is over and continues to the next highest priority threat.

5. This concludes the demonstration. Are there any questions?

Remind the TCs that the handout they received is a controlled item and they must turn it at the end of each day to their RA!

VIDS HANDS-ON TRAINING OUTLINE

Notes to RA:

- **Before beginning, make sure that your simulator has been properly configured, and that kill suppress is on.**
- **Set Radios to proper settings.**
- **Turn Master Power and Turret Power on.**
- **Have VIDS Threat Icon Sheet.**
- **Require the TC to perform all tasks.**
- **Talk TC through each step, then let TC talk RA through as a review.**
- **To go back to correct an error or to change a parameter or option, press ENTER twice and repeat the particular section.**
- **Be prepared to call for threat targets and use target list.**

1.0 - TC Orientation to Commander's Control and Display Panel, Sensors, and Countermeasures

1.1 - VIDS Introduction

1. This training session is designed to give you hands-on orientation and training on the operation of the VIDS Commander's Control and Display Panel (CCDP). You use the CCDP to control the VIDS.

2. VIDS can be operated in automatic, semi-automatic, or manual modes. You will only operate VIDS in automatic and semi-automatic mode.

- These modes will be covered in detail later.

3. In this session we will be using a suite of threat sensors and countermeasures used for one of the four

possible VIDS configurations you will be operating. This particular VIDS configuration suite has five sensors and three countermeasures plus counterfire.

A. 5 Threat Warning Sensors

(1) Laser Warning Receiver (LWR)

Purpose: Gives an audible warning when your vehicle is lased at by enemy vehicles and displays an icon representing the threat location in relation to your hull.

(2) Missile Warning System (MWS)

Purpose: Gives an audible warning when a missile is headed for your vehicle and displays an icon representing the threat location in relation to your hull.

(3) Non-Imaging Sensor (NIS)

Purpose: Gives audible warning tones and verbal messages telling you a helicopter is detected and/or identified as enemy or friendly. It displays an icon representing the threat location in relation to your hull and updates the location as it moves.

(4) Tank Radar Warning Receiver (TRWR)

Purpose: Gives an audible warning when radar from missiles and launch platforms strikes your vehicle and displays an icon representing the threat location in relation to your hull. It also gives you information on status of the radar type,

bearing, and range (to launch platform).

(5) Future Armored System Radar (FASR)

Purpose: Gives you early acquisition of threat platforms by searching, detecting, identifying, and determining range to platforms. Gives an audible warning of detection and displays a threat icon representing its location in relation to the hull.

B. 3 Countermeasure Devices

(1) Combat Protection System (CPS)

Purpose: The CPS disrupts sighting and targeting systems of threat platforms to keep missiles and main gun munitions from hitting your tank.

(2) Missile Countermeasure Device (MCD)

Purpose: The MCD jams the approaching missile's targeting system to keep the missile from hitting your tank.

(3) Pedestal Operated Multi-Ammunition Launching System (POMALS)

Purpose: The POMALS launches smoke grenades to allow you to find cover and concealment.

C. Counterfire.

Purpose: The fastest response to threat vehicles and aircraft. Lays the gunner in general area of the threat.

4. We will begin by training you on both sets of threat warning sensor and countermeasures devices.

5. During the testing phase, we will evaluate a few more countermeasures than the ones used in this training. But, you are receiving training on all the sensors and four of seven possible CMs.

1.2 - Training Overview and Training Objectives

1. The VIDS system will be trained in two parts.

    A. The first part of training will focus on the basic characteristics of the Commander's Control and Display Panel, the sensors, and many of the countermeasures that we will be evaluating the next two weeks.

    B. The second part of training will focus on how to use the VIDS in semi-automatic and automatic modes.

2. By the end of this training session, you should be able to do the following:

    A. Identify VIDS display functions such as the fixed function and programmable function keys.

    B. Use the fixed function keys and programmable function keys to move in and out of VIDS menus.

    C. Identify the components of the VIDS own vehicle icon.

    D. Identify the type and number of available smoke salvos by using the Countermeasure Select

and Countermeasure Stores Fields.

E. Develop a basic understanding of the available VIDS sensors and countermeasures for this configuration.

1.3 - General Information

Note to RA: Allow the TC to touch the screen after you explain and demonstrate.

1. To activate the VIDS system, first power up the tank.

   A. Master power on
   B. Engine on
   C. Turret power on
      - Turret power must be on for VIDS to be on.

TASK: Have the TC power up the tank after you shut it down.

2. The touch screen

   A. To activate a function, put your fingertip on a button. The button is activated when you lift your fingertip from the screen.(the button will highlight).

   B. Please use fingertip only. Avoid using objects other than your finger to touch the screen (e.g. pen, pencil, etc.) because the surface is easily scratched. Treat the equipment with care.

3. Next, turn VIDs on using the POWER Fixed Function Key (FFK).

   A. Touch POWER.

B. When the VIDS is on, your display changes to represent the available countermeasures for a particular VIDS configuration.

TASK: Have the TC power up the VIDS.

4. The Command and Control Display Panel (CCDP)

- The CCDP is the name of the VIDS display itself. The first objective of the training is to familiarize you with the features of the CCDP.

5. Fixed Function Keys (FFK) are the keys that run vertically along the edges of the display.

A. FFKs on left side: CMARM, DSPLY, SPARE, TARGET SELECT, SCROLL DOWN, SCROLL UP, and MAIN

B. FFKs on right side: POWER, SPARE, SPARE, SPARE, SPARE, SPARE, and ENTER

C. The SPARE keys are placeholders for VIDS countermeasure functions.

D. The Fixed Function Keys will be explained as we continue on in this training module.

C. For now, all sensors and countermeasures are functional.

6. Programmable Function Keys (PFK) are the keys that run horizontally along the bottom of the display.

A. You use these keys to choose what menus and functions you want to have available on

your VIDS CCDP.

B. Unlike the Fixed Function Keys that always perform the same functions when you press them, the Programmable Function Keys vary in function.

C. Press the PF Key that appears beneath the function you want.

D. For example, to go into the NORM menu, you press PF1 instead of pressing the NORM box itself.

E. Once you have pressed the PF Key that you want, press the ENTER key in the lower right corner.

TASK: Have the TC go into the NORM menu.

F. To go back to the previous menu, press the ENTER FFK again.

TASK: Have the TC press the ENTER FFK again to get back to the Main menu.

7. The Main Menu

A. The menu that you see when you first get in the vehicle and power up the VIDS is called the Main Menu.

B. There are only two main menu options, NORM and SETUP.

(1) Since you will be using VIDS system default settings, you will not receive training on SETUP functions.

(2) You will use the NORM menu options in the next segment of training to establish which **mode** you want VIDS to be in.

(3) Before proceeding to that part of training, you need a more detailed explanation of the VIDS CCDP and the VIDS own-vehicle icon.

8. The VIDS icon

A. The VIDS CCDP is non-directional (i.e., the top of the display does not represent north or the bottom south).

B. However, the top of the VIDS display screen does represent the front of the vehicle's hull.

C. Hull Indicator

(1) The hull indicator is always stationary.

(2) The hull indicator does not rotate when the tank neutral steers.

D. Turret Pointer - is the bold, thick line in center of display which indicates the line of sight of the turret/main gun.

9. Sector Display

A. Countermeasure Sector - inner red circle

- The countermeasure sector is no longer functional for this evaluation and will not provide you with any useful display information.

B. Threat Icon Field - white space between inner and outer circle

(1) Threat icons will appear in this field.
(2) The icons are not representative of range.
(3) We will examine the types of threat icons later in this session.

C. Alert Sector - outer blue circle

(1) The alert sector corresponds with the amount of area currently covered by sensors.
(2) As you can see, the current VIDS configuration provides 360 degree alert sector coverage.
(3) This 360 coverage is the automatic default of the system.
(4) When a threat is sensed, the VIDS system issues a threat warning tone in the headsets.
(5) When a helicopter is sensed or identified, the VIDS system issues a verbal message about the helicopter.

10. Field and Indicator Displays

A. CM SELECT Field - Upper left hand corner

(1) This information field provides you with countermeasure status.
(2) The TYPE column gives you the type of grenade (VIS and IR) and countermeasures available for this configuration.
(3) The STATUS column gives the number of smoke grenades that will be fired or the current state of the countermeasure (either OFF, STBY or ON).

TASK: Ask the TC what are the number of rounds available for launch. **(Answer: 4 for VIS, 4 for IR)**

B. CM STORES Field - Below CM SELECT field

(1) This field provides you with the available expendable countermeasures remaining.

(2) The TYPE column gives you the type of expendable grenades, flares, or Tank Countermeasure System deflectors remaining. In this configuration we only have grenades so it indicates VIS and IR.

(3) The RNDS column indicates the number of expendables currently stored.

TASK: Ask the TC what are the number of rounds stored by type. **(Answer: 16 for VIS, 16 for IR)**

C. Threat Coordinate Field - Upper right hand corner

- This field provides you with the type of threat (depending on the sensor), the elevation (EL) and azimuth (AZ) in degrees, and the range (RG) (depending on the sensor).

D. CM ARMED Indicator - top of display

(1) This field indicates whether countermeasures are ready on SAFE or are ready to fire (ARMED).

E. User Alert Field - Lower right hand corner

- This warning indicator provides you with priority information concerning VIDS warning systems and countermeasure systems.

F. Mode Indicator - lower right hand corner below user alert indicator

(1) This indicator indicates the mode you are currently operating the VIDs in.
(2) When no indicator is present (system default), there is no indicator.
(3) When you place CM and/or CF in semi-automatic mode, the indicator will indicate SEMI followed by the CM and/or CF.
(4) When you place CM and/or CF in automatic mode, the indicator will indicate AUTO followed by the CM and/or CF.

1.4 - The Sensors

1. The 5 sensors available in this VIDS configuration are the Laser Warning Receiver (LWR), the Missile Warning System (MWS), the Non-Imaging System (NIS), the Future Armored Radar System (FASR), and the Tank Radar Warning Receiver (TRWR).

A. Laser Warning Receiver

(1) The LWR detects threat vehicles that lase your tank out to a range of 5000 meters.
(2) The LWR will not detect a friendly lase.
(3) The LWR will give you early warning of laser designating and laser beam riding missiles.

B. Missile Warning System

(1) The MWS detects boosters/sustainers from ATGMs out to a range of 6000 meters.
(2) The MWS gives you early warning of any missile launches.

C. Non-Imaging System

(1) The NIS detects helicopters out to 10km and readily identifies them by 7km.
(2) The NIS will update your display by repainting the icon periodically.
(3) The NIS will give you warning tones and voice messages upon detection and voice messages upon identification.

D. Future Armored System Radar

(1) The FASR actively searches, detects, and classifies moving threat platforms for target acquisition out to a range of 5000 meters.
(2) FASR is the only sensor appearing as a Fixed Function Key (located on the right hand side).

E. Tank Radar Warning Receiver

(1) The TRWR provides early warning of radar

related weapon systems.
(2) The TRWR detects missiles using RF uplinks and gives the bearing.
(3) The TRWR provides the range of the threat platform using radar to control the ATGM.

2. You will get to see how the sensors work in training later today.

3. For now, we will continue on to the VIDS countermeasure components.

1.5 - The Countermeasure Components

1. There are 3 functional countermeasure components of the current VIDS configuration: the Combat Protection System (CPS), the Missile Countermeasure Device (MCD), and the pedestal Operated Multi-Ammunition Launch System (POMALS).

A. Combat Protection System

(1) The CPS uses directed energy to disrupt optical sights of the threat systems.
(2) The CPS is effective out to a range of 5000 meters.
(3) It has a coverage width of 20 degrees.

B. Missile Countermeasure Device

(1) The MCD jams the infra red (IR) sighting device guiding the ATGMs.
(2) The MCD is 90-98% effective against missiles in field of view for two seconds or more.

C. Pedestal Operated Multi-Ammunition Launch System

(1) The POMALS launches countermeasure grenades to provide temporary concealment from threat platforms firing rounds or missiles at your tank.
(2) Visual (VIS) grenades obscure visual acquisition and appear as white smoke.
(3) Infra red (IR) grenades obscure IR acquisition and appear as brown smoke.
(4) One grenade covers 15 degrees; the default is 2 grenade salvos to cover 30 degrees.
(5) Only 16 of each type of grenades are available per side; 32 grenades total.
(6) Remember, the POMALS provides temporary concealment only. It will not stop the round or missile fired at your tank.
(7) **Once you have fired either type of smoke grenades, keep moving to find cover and concealment. It is best to discuss with your driver beforehand what you want him to do during an engagement. We cannot overemphasize the importance of the driver's reactions to a threat attack.**

2. You will have the opportunity to use these devices later.

3. Now let's review some of the things we covered. I will ask you to show me parts of the display, tell me about the areas, and/or explain or tell me facts about what we covered. I will go back over anything you feel unsure about before we proceed to the next part of training.

1.6 - VIDS PRACTICE EXERCISES

RA: The following questions should be corrected and explained if the TC answers incorrectly. Review any areas he is unsure of. Answers are provided after each item. Give the TC a 5 minute break if needed before resuming the next part of training. Let the Evaluation Director or Battlemaster know if giving a break.

PRACTICE EXERCISES

VIDS

TC ORIENTATION

1. Point to the Fixed Function Keys.

CMARM, DSPLY, SPARE, TARGET SELECT, SCROLLDOWN, SCROLL UP, MAIN, POWER, SPARE, SALVO, JAM, SPARE, SPARE, and ENTER

2. Point to the Programmable Function Keys.

NORM and SETUP

3. Identify the field that provides you information regarding type and status of countermeasures.

Upper left of display. Tells TC the type of CM and status. Status indicates rounds of VIS or IR grenades fired per salvo and whether the CM is OFF, ON, or in Standby.

4. How many VIS and IR rounds are left?

See the CM STORES field for correct answer. Should be 16 of each.

5. Where would you find the direction or bearing of a threat missile?

Threat Coordinate Field in upper right corner.

6. How many sensors are available in this VIDS?

Five. LWR, MWS, NIS, FASR, and TRWR.

7. How many countermeasures are available in this VIDS configuration?

Three. CPS, MCD, and POMALS.

2.0 - VIDS Operations

2.1 - Introduction to VIDS Operations

1. The first part of VIDS training focused on the basic characteristics of the VIDS CCDP, sensors, and countermeasures.

2. The second part of VIDS training will focus on understanding threat icons, understand VIDS operations in different modes, and practice using VIDS in semiautomatic and automatic modes.

3. Training Objectives:

By the end of this second VIDS training session, you should be able to do the following:

A. Using a handout depicting threat icons, identify types of threat icons displayed on the VIDS CCDP.

B. Be able to select threat icons and read their type, azimuth, and elevation from the threat coordinate field.

C. Explain the difference between semi-automatic and automatic modes of countermeasures and counterfire.

D. Place VIDS countermeasures and counterfire in semi-automatic and automatic modes.

E. Within two seconds of a VIDS sensor warning, activate countermeasures and counterfire in the semi-automatic mode.

F. Delete low priority icons from the CCDP (after counterfire has been completed), using the TGTSEL Fixed Function Key.

2.2 - Sensors and the Threat Display

1. When the Laser Warning Receiver (LWR), Missile Warning System (MWS), Non-Imaging System (NIS), Future Armored Systems Radar (FASR), or Tank Radar Warning Receiver (TRWR) sensors perceive a threat, you will hear an audible warning and see an icon representing the threat on the Commander's Control and Display Panel (CCDP).

2. Threat Icon Field - the area between the red circle and blue circle

A. Threat icons appear in the Threat Icon Field, relative to your **hull** after being detected by VIDS sensors.

B. Important Note - the distance between your tank icon and any threat icons do not reflect range from your vehicle to that threat.

C. The highest priority threat icon will blink.

D. Icons will remain on your display for 30 seconds, unless you manually delete the icon.

RA: Hand the TC the threat icon sheet.

E. Explain the types of threat icons.

(1) Icons are diamond-shaped if threats, U-shaped if unknown, or are a U or diamond with a horizontal dash inside if helicopters. The

modifier (letter) beneath the icon indicates the threat type.

RA: Use the threat symbol sheet as you talk about each icon and symbol.

a. An "A" beneath the icon indicates the detection of an ATGM launch.

b. A "B" beneath the icon indicates the detection of a Laser Beamriding Missile.

c. A "D" beneath the icon indicates the detection of a Laser Designated Missile.

d. An "R" beneath the icon indicates the detection your vehicle being painted by an enemy Laser Rangefinder.

e. An "M" indicates a muzzle flash.

f. An "F" beneath the icon indicates detection of a weapon platform with the FASR sensor.

(2) If multiple hostile threats, unknowns, or helicopters of the same type are detected at the same location, VIDS places the icon within the same icon on the CCDP. For example, a diamond within a diamond would be multiple hostile threats in the same location.

(3) If multiple hostile threats of different types are at the same location, VIDS places the higher priority threat icon farther from the hull icon.

(4) The blinking icon represents the highest priority threat.

TASK: Have the TC describe the threat types that would appear on his CCDP:

Question:	**Answer:**
Bar inside diamond	Enemy helicopter
Diamond with B	Enemy Beamrider missile
U within a U with a bar in middle	Multiple Unknown helicopters
U with an A	Unknown ATGM
Diamond with R and Diamond with Bar with D	Enemy tgts with LRF and Laser Designator

F. Icon Deletion:

(1) Icons stay on your CCDP until they are manually deleted or no new reports are sensed from that threat for 30 seconds.

(2) VIDS has no idea when a threat is killed. Therefore, icons representing dead threats may stay on your screen and keep new, live threats from appearing on the CCDP.

****WARNING: BY FOLLOWING THESE PROCEDURES YOU WILL BE LOSING DATA AND THERE IS NO WAY OF RETRIEVING THIS DATA.**

(3) When a threat icon is no longer needed, use the following method to clear it from your screen.

(4) If the current icon is blinking and it is defeated (through CM and/or counterfire), it should be removed. If the enemy threat was just defeated, you can delete it while it is flashing by pushing the TARGET SELECT Fixed Function Key.

(5) If it is no longer flashing, highlight the icon using the Scroll Up or Scroll Down keys.

(6) These keys let you scroll up and down the list of targets remaining on the screen. The targets are in order of priority set by the VIDS.

(7) Touch the TARGET SELECT key to delete the icon and the VIDS system will go to the next highest priority target.

(8) You will **not be able to retrieve deleted icon information.** This fact must be balanced against the need to keep your CCDP clean for new threats and so you do not get confused over what has been defeated and those that have not.

TASK: You have just killed a T-80 tank shooting an ATGM. The ATGM icon was countered but still remains on the screen and is blinking. Describe the procedures to delete the ATGM icon from your CCDP. **(<u>Push Target Select</u>.)**

3. Threat Coordinate Field - upper right hand corner

A. Information about the highest priority threat (the one that's blinking) is displayed in the threat coordinate field.

B. It displays the type, azimuth (AZ) and

elevation (EL) of the highest priority threat. Depending on the sensor, it may also give the range to the threat platform, i.e., tank, BDRM, helicopter.

C. If a higher priority threat is detected, the VIDS system will replace lower priority threat information with the higher priority threat information in the threat coordinates field and the new high priority threat icon will be blinking.

D. You can view information on lower priority threats by pressing on the SCROLL UP or SCROLL DOWN FFKs on the left side of the display. This selects icons up or down based on the priority scale, not in relation to their position on the display.

E. The icon currently chosen will blink and the azimuth and elevation information in the threat coordinate's field will change to correspond with the blinking threat.

RA: Since TC has not been taught modes yet, place the CM in automatic mode for the next event.

PERF TASK 1: (Call for Target Event #2, A T-80 tank will fire a Beamrider ATGM at the tank.) Have the TC: (1) identify the icon, (2) tell you the elevation and azimuth, and (3) delete it from the screen after it has been countered by the VIDS. **(Call for T-80 to be removed after TC performs target deletion.)**

<u>2.3 - Countermeasures and Prioritization</u>

1. Upon contact with the enemy, VIDS will prioritize threats received from the five sensors.

2. VIDS will use the prioritization and threat information to determine the appropriate countermeasure in all modes.

3. For example, the highest priority threats are those with laser ranging and esignating capability. These could be weapons platforms lasing you for firing main gun munitions or launching laser directed ATGMs.

4. The lowest priority threats are those ATGMs that are IR guided.

5. In this particular threat situation, the following should happen. The Combat Protection System would be activated first to disrupt optical tracking systems such as tank optical sights. After CPS, the Missile Countermeasure Device would activate and jam the threat's IR tracking system, if the missile is an IR tracked missile. Third, the Pedestal Operated Multi-Ammunition Launch System would launch grenades to conceal your tank from observation or break the tracking beam.

4. If you watch carefully, the CM FFK will light. Then in the CM SELECT field, you will see which countermeasure is activated first. If smoke (VIS or IR) or other CMs are activated, you will see the CM highlight briefly, then the Status block beside should briefly highlight yellow then white and change its text to ON. For example, if CPS is activated, it will highlight then its status field should turn from yellow to white and the text should go from STBY to ON.

PERF TASK 2: (Call for Target Event #4, a HIND attack with ATGM AT-9.) Have the TC track the sequence of alerts and CM to see the sequence. Review what happened after the CM engagement. **(Call for HIND attack to cease.)**

5. **Counterfire is always the last response employed by VIDS after the others have been ruled out by lack of availability.** Counterfire moves the gun tube to face the threat so that the gunner can engage. After the gun is layed in the direction, the gun tube may not be corrected for elevation so you would have to give the direction for the gunner to make the final lay (or you will correct). Proper fire commands and sequence should be followed at this point.

6. Before each tested VIDS configuration, you will be told which sensors and countermeasures you have available. You will also be told the capabilities and limitations the particular configuration has.

7. For example, in this particular configuration of sensors and countermeasures, you can detect all the different threat systems and their munitions (rounds and missile). This

configuration also has the capability to defeat all those munitions.

2.4 - VIDS Operating Modes

1. Overview of the three VIDS Operating Modes

A. VIDS has three modes: manual, semi-automatic, or automatic. You will only be using semi-automatic and automatic mode during this evaluation.

B. During the test scenarios, we will tell you which mode you will use to operate the available sensors and countermeasures. **You will not be allowed to change modes once you begin the exercise.**

C. Mode Indicator - located directly below User Alert information field in the lower right hand corner

(1) Indicates the active VIDS operating mode: Semi or Auto.

NOTE: When the VIDS is in the manual mode, there is no indicator. Manual mode is the automatic default when the system is powered up.

(2) Mode information is only displayed in the NORM menu.

TASK: Have the TC access the NORM menu.

D. User Alert information field - located in lower right-hand corner of display

- Consists of various information "boxes" designed to provide the operator with timely feedback of

system status, system faults, or operator errors.

E. Semi-Automatic mode

(1) Semi-Automatic mode involves countermeasure and counterfire functions that are only activated when the TC pushes the VIDS activation button on the commander's control handle. **(RA: Point to the right top black button as you tell him.)**

(2) Semi-automatic mode includes activating the recommended CMs in the CM STATUS field and automatic target cuing for counterfire.

F. Automatic mode

(1) In automatic mode, most actions are taken by VIDS, without any intervention by the TC (hands-off).

(2) However, the system still requires the TC to delete a target from the display after engaging targets from counterfire. The system does not automatically know when engagements are finished.

****WARNING: For safety and crew teamwork, remember to always issue the correct commands before engaging or moving the turret. Make sure your crew knows what mode VIDS is in.**

2. Using Semi-Automatic Mode

A. VIDS uses sensor information to display an icon and make judgements on which countermeasure to employ.

B. First VIDS provides a 3 second tone in the headset. (You may also receive a voice message if it

is a helicopter.) Also the icon appears on the CCDP and information on threat type appears in the threat coordinate field.

C. In semi-automatic mode, the TC initiates the VIDS when he pushes the VIDS activation button on his Commander's Control Handle. You may be prompted by a synthetic female voice announcing "VIDS is waiting." The VIDS takes over from there, making countermeasure or counterfire decisions based on VIDS sensor information and what countermeasures are available.

D. Counterfire in Semi-Automatic Mode

(1) Counterfire is the lowest priority response to a threat.

(2) Counterfire moves the gun tube to the threat location indicated by a VIDS sensor.

(3) Counterfire permits fast acquisition and engagement by the gunner, but does not interfere with the missile or main gun round that has been fired at your tank.

(4) Because VIDS does not pull the trigger and has no way of knowing what the results of the CF are; you must manually delete the icon off of your CCDP or scroll to the next priority.

(5) VIDS will employ countermeasures before employing counterfire.

(6) Semi-Auto Counterfire is selected by depressing the CFIRE PFK followed by the ENTER FFK.

(7) Your Mode Indicator should read "Semi-CF."

TASK: Have the TC select Semi-Automatic counterfire and check his Mode Indicator.

(8) To engage the semi-auto counterfire option, the TC needs to push the VIDS activation button on the Commanders Control Handle.

(9) The main gun will traverse to the hostile target where the gunner or you can make the final correction and engage the enemy. (Use normal gunnery procedures at this point.)

PERF TASK 3: (Call for Target Event #5, a T-80 attack with main gun.) Have the TC engage the target using semi-automatic counterfire and delete the icon from the CCDP. Review what happened after the engagement.

RA: After the event is completed. Take CFIRE out of SEMI for the next task.

E. Countermeasures in Semi-Automatic mode

(1) CPS, MCD, and POMALS will be employed before counterfire.

(2) You place the available countermeasures in semi-automatic mode by depressing the CM PFK followed by the ENTER FFK.

(3) Your Mode Indicator should read "Semi: CM."

TASK: Have the TC set up the countermeasures in semi-automatic mode.

(4) Now when you engage the VIDS activation button, VIDS will take the appropriate countermeasure action based on the sensor's assessment of the threat and it's priority.

(5) The CPS in Semi-Automatic Mode

(a) If the VIDS recommends the CPS as a countermeasure, VIDS will slew the CPS independently to face the threat and wait for activation by you.

(b) The CPS button will highlight and the status will change to STBY in the CM SELECT field.

(c) When you activate the VIDS activation button, the CPS status in the CM SELECT field will change to ON and stay on for 3 seconds.

(d) After CPS energy goes off, the CPS status will change to OFF. VIDS will respond to the next priority threat. The icon will no longer flash, but will remain on the display for your reference.

(6) The MCD in Semi-Automatic Mode

(a) If the VIDS recommends the MCD as a countermeasure, VIDS will slew the MCD independently to face the threat and wait for activation by you.

(b) The MCD button will highlight and the status will change to STBY in the CM SELECT field.

(c) When you activate the VIDS activation button, the MCD status in the CM SELECT field will change to ON and stay on for 3 seconds.

(d) After MCD energy goes off, the MCD status will change to OFF. VIDS will respond to the next priority threat. The icon will no longer flash, but will remain on the display for your reference.

(7) POMALS in semi-automatic mode

(a) In semi-automatic mode, the VIDS determines what type of smoke grenade is needed and will fire salvos after the CPS and/or MCD are employed.

(b) When POMALS is recommended by the VIDS system, the VIS or IR buttons in the CM SELECT field will highlight and their status will change to STBY.

(c) When you press the VIDS activation switch, the VIS or IR status will change to ON while the system launches the grenades.

(d) These grenades provide coverage between the highest priority target and the host vehicle, **regardless of the LOS of the main gun.** You will see 4 dots appear between your threat icon and the direction of the threat icon.

(e) If you look out the vision blocks you will see smoke grenades exploding. If you look at the CM STORES field you will see the number of available rounds decrease.

(f) You can tell by the color of the smoke (VIS is white, IR is brown) which type was employed as well.

(g) After smoke grenades are dispensed, VIDS will respond to the next priority threat. The icon will no longer flash, but will remain on the display for your reference or until you delete it.

****Remember that the icon is only a "snapshot" of an event that has already taken place. VIDS does not track the OPFOR. It only tells you what direction the OPFOR has fired from.**

(h) As soon as the smoke grenades have been fired, **move to find cover and concealment.**

PERF TASK 4: (Call for Target Event #3, Hind with AT-9 and 2 BRDMs with AT-4s.) Have the TC: (1) identify threats, (2) track the CMs recommended, (3) engage them by activating with the VIDS button, and delete their icons after they have been defeated. Have the TC tell you the sequence of events then discuss what happened with him after the engagements are complete. **(Call and stop threats after the engagement is done.)**

RA: Put CM back to manual.

TASK: Have the TC place CM and CF in semi-automatic mode.

PERF TASK 5: (Call for Threat Event #7, 2 BRDMs with AT-2C ATGMS spread.) Have the TC employ the VIDS in semi-automatic mode. After the engagement, have him let the icons delete themselves after 30 seconds. Ask th TC to relate the sequence of events. Review what happened with him. Then place the CM and CF back into manual mode before proceeding.

3. Using Automatic Mode

A. When the VIDS' countermeasure and counterfire functions are in automatic mode, the VIDS performs automatically in response to a threat.

B. First VIDS provides a 3 second tone in the headset. (you may also receive a voice message if it is a helicopter.) Also the icon appears on the CCDP and information on threat type appears in the threat coordinate field.

C. During the performance of an AUTO response, the the CPS, MCD, and VIS or IR fields in the CM SELECT

field will be lit and their status will change from OFF to STBY to ON as an indicator to the TC that VIDS is active.

D. If CMs are busy and counterfire is recommended the main gun will automatically slew to the vicinity of the current threat.

E. Counterfire in Automatic Mode

(1) Counterfire in automatic mode slews the turret and positions the main gun in the vicinity of the threat. You or the gunner should use manual gunnery procedures at this point for engagement. The VIDS system will not operate until you signal the end of an engagement.

(2) Once the threat is destroyed, you must remove the icon or scroll to the next highest priority. To remove the target from your screen, you will have to push the target select (TGTSEL) button.

(3) To set up this option, push the AUTO PFK, then the CF PFK, then the ENTER FFK.

TASK: Have the TC set up counterfire in the AUTO mode.

(4) You should see a message of "AUTO: CF" in the Mode Indicator.

PERF TASK 6: (Call for Target Event #8, 2 T-80 main gun attack.) Have the TC track and engage the tanks. Remind him he will have to use Target Delete after the first successful engagement to get VIDS to reactivate the automatic CFIRE. Discuss what happened with him after the second engagement.

RA: After this event, return the CF to manual.

F. Countermeasures in Automatic Mode

(1) The TC has the option to engage the AUTO CM mode which will result in the immediate use of CPS and/or MCD and/or dispensing of smoke once an appropriate threat or threats are detected by the VIDS sensors.

(2) The automatic mode option is set up by pressing the AUTO PFK followed by the CM PFK and the ENTER FFK.

TASK: Have the TC set his countermeasures in automatic mode.

(3) You should get a message of "AUTO: CM" in the Mode Indicator.

(4) The CPS in Automatic Mode

(a) If the VIDS selects the CPS as a countermeasure, VIDS will slew the CPS independently to face the threat.

(b) The CPS button will highlight and the status will change to STBY briefly in the CM SELECT field.

(c) Upon activation the CPS status in the CM SELECT field will change to ON and stay on for 3 seconds.

(d) After CPS energy goes off, the CPS status will change to OFF. VIDS will respond to the next priority threat. The icon will no longer flash, but will remain on the display for your reference.

PERF TASK 7: (Call for Target Event #6, Hind with AT-6 ATGM attack.) Have the TC track what happens and discuss event afterwards to see if he remembers sequence. **(Call to have HIND cease fire.)**

(5) The MCD in Automatic Mode

(a) If the VIDS selects the MCD as a countermeasure, VIDS will slew the MCD independently to face the threat.

(b) The MCD field will highlight and the status will change to STBY briefly in the CM

SELECT field.

(c) Upon activation the MCD status in the CM SELECT field will change to ON and stay on for 3 seconds.

(d) After MCD energy goes off, the MCD status will change to OFF. VIDS will respond to the next priority threat. The icon will no longer flash, but will remain on the display for your reference.

(6) POMALS in Automatic mode

(a) In automatic mode, the VIDS determines what type of smoke grenade is needed and will fire salvos after the CPS and/or MCD are employed.

(b) When POMALS is selected by the VIDS system, the VIS or IR buttons in the CM SELECT field will highlight and their status will change to STBY briefly.

(c) Upon activation, the VIS or IR status will change to ON while the system launches the grenades.

(d) These grenades provide coverage between the highest priority target and the host vehicle, **regardless of the LOS of the main gun.** You will see 4 dots appear between your threat icon and the direction of the threat icon.

(e) If you look out the vision blocks you

will see smoke grenades exploding. If you look at the CM STORES field you will see the number of available rounds decrease.

(f) You can tell by the color of the smoke (VIS is white, IR is brown) which type was employed as well.

(g) After smoke grenades are dispensed, VIDS will respond to the next priority threat. The icon will no longer flash, but will remain on the display for your reference.

(h) As soon as the smoke grenades have been fired, **move to find cover and concealment.**

****WARNING: EVEN THOUGH THE ICON IS NO LONGER FLASHING, THE THREAT IS STILL OUT THERE LASING ON YOU!**

RA: Put CM and CF back into manual.

TASK: Have the TC put CM and CF into AUTO mode.

PERF TASK 8: (Call for Target Event #1, 3 BRDMs with AT-2 ATGMs attack.) Have the TC: (1) identify threats, (2) use Target Select to return to automatic mode after killing each threat platform, and issue to you a spot report. Have him review events sequence and discuss details after he completes spot report.

RA: Ask him if he would like to review anything in preparation for his Skill Test. He may need more practice if he appeared to be having trouble in certain areas (i.e., identification, CM priorities, etc.) Go back to those objectives and review any items you feel he is weak on. After review, you may escort him to the break area.)

VIDS SKILLS TEST

(RA COPY)

Note to RA: Retrain all NO GOs before going on to the next item. VIDS performance items should be reviewed. If the TC needs retraining on an event, go to the alternate event (A or B). VIDS should be powered up with default parameters. Make sure the system is back to the Main Menu before beginning. Once the TC has entered the NORM Menu options, do not let the TC go back to the Main Menu to regain manual control.

"At this time, we would like you to take a look at how well our training assisted you in learning how to use VIDS. The purpose of this evaluation is to judge the quality of <u>the training</u> you've received up to this point. We want to know whether or not we've trained you well enough to operate the VIDS system and which functions you find particularly easy or difficult to operate. We hope to use the results to improve our training for future VIDS research."

"This evaluation consists of a set of evaluation items which will require you to answer questions about the VIDS system and to use the VIDS equipment. After a RA reads each item, you will have the opportunity to answer or perform on the equipment. Once you've completed the item, the RA will indicate to you if you answered or performed it correctly. If necessary, you will be retrained immediately."

"Since you don't have a driver for this evaluation, you will operate the VIDS from a defensive static position when using the VIDS equipment. You are not graded on whether you live or die, just whether or not you perform the tasks correctly."

"You will have Configuration 3 sensors and countermeasures available to you during this evaluation." **(Refresh his memory from list provided.)**

"Do you have any questions before we begin? If not, please move to your SIM to begin the evaluation."

1. Identify the following threat icons:

   RA: Show sheet and ask him to identify the numbered icons.

   Answers:
   * 1. Unknown ATGM
   * 2. Multiple enemy
   * 3. Unknown Helicopter with Laser Designator
   * 4. Enemy lasing with Rangefinder

   _____ OK _____ Retrain

2. What is the purpose of the TGTSEL key?

   * To select icons on the screen for deletion

3. How do you select inactive icons and view information about them?

   * Use Scroll Keys until the icon you want blinks, then refer to the Threat Coordinate Field for Type, Azimuth, and/or Range information.

4. VIDS has dispensed 2 salvos of VIS grenades.

   A. How many grenades are fired per salvo?

   B. What field tells you the number of grenades dispensed per salvo?

   C. What field indicates the number of grenades remaining?

   D. How many grenades would be left?

   Answers:
   * A. 4
   * B. CM Select
   * C. CM Stores
   * D. 8

5. You have just killed a tank after counterfire. Describe the sequence to return to VIDS operations.

_____ Select the icon of the threat tank (if not blinking, use the Scroll Key to select).

_____ Then use the TGTSEL Key to delete the icon.

6. Place the VIDS into Automatic CM and CF mode.

_____ Press NORM <Enter>

_____ Press AUTO CM <Enter>

_____ Press AUTO CF <Enter>

_____ Check the mode indicator for AUTO: CM CF

_____ OK _____ Retrain

RA: If TC misses performing critical tasks (marked with asterisk) or appears confused about sequence (confused enough that he needs retraining in performance) call for Target Event 1A (2 T-80s main gun, CPS and smoke possible) for Item 7 or call for Target Event 2A for Item 9 (1 Hind with Laser Designation, CPS activated).

7. **RA: Call BattleMaster for start of Event 1 (2 BDRMs w/AT2). Tell the TC that he** will be expected to relate the sequence of events after the engagement.

    _____ Audible Alert tone

    _____ U or Diamond icons with A or R

    _____ CPS and/or MCD activate to defeat ATGMs

    * _____ Counterfire reaction (if applicable)

    * _____ TC uses main gun to kill targets

    * _____ Uses TGTSEL to delete icons

    _____ OK _____ Retrain

    RA: Return operation to Main Menu.

8. Place the VIDS into Semiautomatic CM and CF mode.

    _____ Press NORM <Enter>

    _____ Press CM <Enter>

    _____ Press CF <Enter>

    _____ Check the mode indicator for SEMI: CM CF

    _____ OK _____ Retrain

9. **RA: Call BattleMaster for start of Event 2 (1 T-80, main gun). Tell the TC that he** will be expected to relate the sequence of events after the engagement.

_____ Audible Alert tone

_____ U or Diamond icons with R appearing

_____ CPS recommended

* _____ TC activated button within 2 seconds of alert

_____ CPS activated

* _____ Counterfire reaction (if applicable)

* _____ Uses main gun to kill target

* _____ Uses TGTSEL to delete icon

_____ OK _____ Retrain

Threat Icons

1	2
3	4

SKILLS EVENTS TEST LIST

OPERATIONAL MODE	EVENT NUMBER	SAF ARRAY	START POINT	ENGAGEMENT RANGE
AUTO	1	2 BDRMs w/ AT2 (spread)	4 KMS	2 KMS
SEMI	2	1 T-80 Main Gun	4 KMS	2 KMS
AUTO	1A	2 T-80s w/ AT2 (spread)	4 KMS	2 KMS
SEMI	2A	1 HIND w/ AT6	5 KMS	4 KMS

* Configuration 3

PLATOON DEFENSIVE STX OPORD

SCENARIO BRIEF

FP EVAL DEFENSIVE STX

Overview. You are 1st Plt, A Co., 2-33 Armor which is task organized as Task Force Tank. The task force is conducting a tactical road march to a different area of operation. 1st Platoon is providing security to the task force from BP 01 while the rest of TF Tank moves through canalized terrain.

1. Situation.

a. Enemy. Enemy forces in area are from 1st GTD. The 1st GTD is consolidating itself in preparation for upcoming operations. The division strength is 80% and morale is high. The enemy is capable of launching aerial attacks using HIND-F aircraft with AT-6 and AT-9 ATGMs. Enemy armor includes T-80s with AT-11 and BRDMs with AT-2 and AT-4. Expect the enemy to conduct aggressive recon efforts.

b. Friendly. No change.

2. Mission. Upon receipt of mission, 1st Plt conducts hasty occupation of BP 01 to guard TF Tank during tactical road march.

3. Execution. Orient southeast between TRPs 01 & 02. Report all enemy sensings, observations, and contact. ADA wpns status is yellow/hold.

4. Service Support. No change.

5. Command and Control. No change.

DEFENSIVE STX

FILE	EVENT	SAF ARRAY	START POINT	ENGAGEMENT RANGE	MODE	CONFIG
	1a	2 HIND W/ AT6	10,000	4,000	N/A	Baseline
	1b	3 BDRM W/ AT4	4,000	1,500		
	1c	3 T-80 W/ AT11	5,000	3,500		
	1d	3 T-80 Main Gun	4,000	1,500		
	1e	9 T80 W/ AT11 and Main Gun	5,000	3,500		
	2a	2 HIND W/ AT6	18,000	5,000	SEMI	1
	2b	3 BDRM W/ AT4	5,000	2,500		
	2c	3 BDRM W/ AT2	6,000	2,000		
	2d	3 HIND W/ AT6	18,000	5,500		
	2e	3 HIND W/ AT9	18,000	5,000		
	3a	3 BDRM W/ AT4	4,000	1,500	AUTO	2
	3b	3 HIND W/ AT9	12,000	5,000		
	3c	3 BDRM W/ AT2	4,000	2,000		
	3d	3 T80 W/ AT11 and Main Gun	6,000	4,000		
	3e	9 T80 W/ AT11 and Main Gun	6,000	4,000		
	4a	3 HIND W/ AT6	12,000	5,000	SEMI	3
	4b	3 BDRM W/ AT4	5,000	1,500		
	4c	9 BDRM W/ AT2	4,000	2,000		
	4d	3 HIND W/ AT9	12,000	5,000		
	4e	9 T80 W/ AT11 and Main Gun	6,000	4,000		
	5a	9 BDRM W/ AT2	4,000	2,000	AUTO	4
	5b	3 BDRM W/ AT4	6,000	1,500		
	5c	3 HIND W/ AT9	18,000	5,000		
	5d	9 T80 W/ AT11 and Main Gun	6,000	4,000		
	5e	27 T-80 W/ AT11 and Main Gun	7,000	4,000		

VIDS JOB AID

VEHICLE

INTEGRATED

DEFENSE

SYSTEM

VIDS COMPONENTS

WARNING SENSORS

LWR - High Accuracy Laser Warning Receiver

- Detects laser ranging and designation

FASR - Future Armored System Radar

- Detects/identifies moving weapons platforms

MWS - Missile Warning System

- Detects ATGM launch

MFD - Muzzle Flash Detector

- Detects main gun blast

NIS - Non-Imaging Sensor

- Detects and identifies helicopters

TRWR - Tank Radar Warning Receiver

- Detects hostile radar-related warning systems

COUNTERMEASURE DEVICES

CPS - Combat Protection System

- Disrupts optically tracked threat systems

Flares

- Decoys IR directed threats

LCMD - Laser Countermeasure Device

- Decoys laser designator threat systems

MCD - Improved Missile Countermeasure Device

- Disrupts ATGM tracking system

POMALS - Pedestal Operated Multi-Ammunition Launch System

- Obscures visual and IR acquisition capability

TCS - Threat Countermeasure System

- Actively defeats incoming munitions with hard kill

COUNTERFIRE

- Positions main gun toward direction of threat

VIDS TERMS

VIDS	VEHICLE INTEGRATED DEFENSE SYSTEM
CCDP	COMMANDER'S CONTROL AND DISPLAY PANNEL
CCH	COMMANDER'S CONTROL HANDLE
CM(s)	COUNTERMEASURE(S)
CF or CFIRE	COUNTERFIRE
FFK	FIXED FUNCTION KEYS
PFK	PROGRAMMABLE FUNCTION KEYS
LWR	HIGH ACCURACY LASER WARNING RECEIVER
MWS	MISSILE WARNING SYSTEM
MFD	MUZZLE FLASH DETECTOR
NIS	NON-IMAGING SENSOR
FASR	FUTURE ARMORED SYSTEM RADAR
TRWR	TANK RADAR WARNING RECEIVER
CPS	COMBAT PROTECTION SYSTEM
MCD	MISSILE COUNTERMEASURE DEVICE
POMALS	PEDESTAL OPERATED MULTI-AMMUNITION
LAUNCH SYSTEM	
LCMD	LASER COUNTERMEASURE DEVICE
TCS	THREAT COUNTERMEASURE SYSTEM
FLARES	FLARES
A	ATGM
B	BEAMRIDER
D	DESIGNATOR
R	RANGEFINDER
M	MUZZLE FLASH

VIDS COMPONENTS - BASELINE CONFIGURATION

Capabilities:

- Detects all threat platforms and missile launches within 3500m (given LOS) using currently fielded optical-mechanical systems.
- Depends on hand-eye coordination, crew teamwork, and conventional TTPs to counter detected threats (e.g., Evade ATGMs)

Limitations:

- Will not detect threats beyond sights and vision block coverage
- Will not detect missile launches beyond visible range
- No smoke available

VIDS COMPONENTS - CONFIGURATION 1

WARNING SENSORS

LWR - High Accuracy **L**aser **W**arning **R**eceiver

- Detects laser ranging and designation

MWS - **M**issile **W**arning **S**ystem

- Detects ATGM launch

COUNTERMEASURE DEVICES

MCD - Improved **M**issile **C**ountermeasure **D**evice

- Disrupts ATGM tracking system

POMALS - **P**edestal **O**perated **M**ulti-**A**mmunition **L**aunch **S**ystem

- Obscures visual and IR acquisition capability

COUNTERFIRE

- Positions main gun toward direction of threat

Capabilities:

- Detects all ATGM launches
- Detects lases to vehicle by threat platforms
- Actively defeats IR-tracked missiles (AT2C, AT4, and AT6)
- Possibly defeats platform/crew with visible and IR smoke

Limitations:

- No active CM protection against LBR and LD ATGMs (AT9 and AT11)
- No active CM protection to defeat main gun rounds/missiles

VIDS COMPONENTS - CONFIGURATION 2

WARNING SENSORS

LWR - High Accuracy Laser Warning Receiver

- Detects laser ranging and designation

FASR - Future Armored System Radar

- Detects/identifies moving weapons platforms

MWS - Missile Warning System

- Detects ATGM launch

NIS - Non-Imaging Sensor

- Detects and identifies helicopters

COUNTERMEASURE DEVICES

MCD - Improved Missile Countermeasure Device

- Disrupts ATGM tracking system

POMALS - Pedestal Operated Multi-Ammunition Launch System

- Obscures visual and IR acquisition capability

COUNTERFIRE

- Positions main gun toward direction of threat

Capabilities:

- Detects all ATGM launches, identifies threat type (LRF, LBR, LD) and gives bearing
- Detects lases to vehicle by threat platforms
- Detects rotary aircraft type and bearing
- Detects bearing, speed, and location of ground and air platforms
- Actively defeats IR-tracked missiles (AT2C, AT4, and AT6)
- Possibly defeats platform/crew with visible and IR smoke

Limitations:

- No active CM protection against LBR and LD ATGMs (AT9 and AT11)
- No active CM protection to defeat main gun rounds/missiles

VIDS COMPONENTS - CONFIGURATION 3

WARNING SENSORS

LWR - High Accuracy Laser Warning Receiver

- Detects laser ranging and designation

FASR - Future Armored System Radar

- Detects/identifies moving weapons platforms

MWS - Missile Warning System

- Detects ATGM launch

NIS - Non-Imaging Sensor

- Detects and identifies helicopters

TRWR - Tank Radar Warning Receiver

- Detects hostile radar-related warning systems

COUNTERMEASURE DEVICES

CPS - Combat Protection System

- Disrupts optically tracked threat systems

MCD - Improved Missile Countermeasure Device

- Disrupts ATGM tracking system

POMALS - Pedestal Operated Multi-Ammunition Launch System

- Obscures visual and IR acquisition capability

COUNTERFIRE

- Positions main gun toward direction of threat

Capabilities:

- Detects all ATGM launches, identifies threat type (LRF, LBR, LD) and gives bearing
- Detects lases to vehicle by threat platforms
- Detects rotary aircraft type and bearing
- Detects bearing, speed, and location of ground and air platforms
- Detects threat radar weapon systems direction, bearing, range, and status (AT-2C, AT6)
- Possibly defeats platform/crew with visible and IR smoke
- Actively defeats electro-optical systems of all threats within range

Limitations:

- No active CM protection to defeat main gun rounds/missiles

VIDS COMPONENTS - CONFIGURATION 4

WARNING SENSORS

LWR - High Accuracy Laser Warning Receiver
- Detects laser ranging and designation

FASR - Future Armored System Radar
- Detects/identifies moving weapons platforms

MFD - Muzzle Flash Detector
- Detects main gun blast

MWS - Missile Warning System
- Detects ATGM launch

NIS - Non-Imaging Sensor
- Detects and identifies helicopters

TRWR - Tank Radar Warning Receiver
- Detects hostile radar-related warning systems

COUNTERMEASURE DEVICES

CPS - Combat Protection System
- Disrupts optically tracked threat systems

Flares - Decoys IR directed threats

LCMD - Laser Countermeasure Device
- Decoys laser designator threat systems

TCS - Threat Countermeasure System
- Actively defeats incoming munitions with hard kill

COUNTERFIRE
- Positions main gun toward direction of threat

Capabilities:

- Detects all ATGM launches, identifies threat type (LRF, LBR, LD) and gives bearing
- Detects lases to vehicle by threat platforms
- Detects rotary aircraft type and bearing
- Detects bearing, speed, and location of ground and air platforms
- Detects threat radar weapon systems direction, bearing, range, and status (AT-2C, AT6)
- Possibly defeats IR-tracked missiles (AT-2C, AT4, AT6) and IR sighting systems
- Actively defeats electro-optical systems of all threats
- Actively decoys LD ATGMs (AT11)
- Actively defeats incoming munitions

Limitations: • Single shot flares • No visual cover

THREAT SYMBOLOGY

TARGET ID ICONS		TARGET TYPE ICONS	
Hostile Target:	◇	ATGM:	A
Multiple Hostiles:	◈	Beamrider:	B
Friendly:	○	Designator:	D
Multiple Friendlies:	◎	FASR (Detection):	F
Unknown:	∪	Muzzle Flash:	M
Multiple Unknowns:	⋓	Rangefinder:	R
Helicopter (NIS Detection):	▬		

EXAMPLES

◇R	Hostile Target with Rangefinder
⋓M	Multiple Unknowns Firing Main Guns
○F	Friendly Moving Vehicle

Appendix D

Sample Observer Checklists and Logs

Contents of Appendix D:

RESEARCH ASSISTANT CHECKLIST - NAVIGATION TRAINING

Date: ____________ RA Name ____________

Sim Call # ____________

NAVIGATION EXERCISE
RA CHECKLIST
CREW TRAINING

Note to RAs: Put a plus (+) beside those statements that correctly describe this execution of training exercise and a minus (-) beside those items that do not correctly describe it. At the end of the training scenario, please ask the crew members questions about those *asterisked (*)* items with a minus (-) beside them and retrain if necessary before allowing the crew to leave the simulator. The purpose of this exercise is to get the crew comfortable with navigation and working together in Sim World.

TC:

1. ____* The TC kept his mouth far enough away when he transmitted over the intercom/radio to be clearly understood.

2. ____ The TC briefed the gunner and driver before beginning the mission. (Did he tell them where they were going?)

3. ____* The TC knew how to communicate with control and his crew.

4. ____ The TC asked the driver for mileage so he could compute what the mileage should be when they arrive at the CP.

5. ____* During the course of the mission, there was never any indication from the TC or the radio that the tank had gotten lost or misoriented.

6. ____ The TC warned the gunner before he used the commander's override.

7. ____* The TC gave no verbal indication that he was becoming frustrated with any part of the navigation exercise. If so, what was he frustrated with?

____

____

Is this something you can help him with? Extra training? Remember that this is not a test in Navigation. Only practice.

RA Checklist for Navigation Exercise (Cont'd)

8. ____ If the TC used any other means of navigation other than the distance and grid azimuth indicator, what was the method that he used? Did you make him use the method trained in seat specifics for at least 2 CP's?

____

____

Training Notes

____

____

____

____

9. ____* Please have the TC stop between CP 3 and CP 4 and call his current grid location into control.
TC's called in GRID ________________
Control's vehicle location.________________

10.____* The TC verified possible targets were enemy prior to issuing a fire command.

11.____* TC used a good fire command.(This is important from a crew teamwork view.)

Driver

1. ____* The driver did not steer the tank into dark blue water.

2. ____ The driver followed the TC's instructions on maneuvering the vehicle.

3. ____* The driver said point before the last digit of the mileage.

4. ____ The driver gave no verbal indication that he was intentionally engaging in or encouraging "risky" behavior.

5. ____ The driver used Tac idle only when he was stationary.

RA Checklist for Navigation Exercise (Cont'd)

6. ____ The driver did not throw a track.

7. ____ The driver ID'ed at least one enemy vehicle.

Training Notes

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Gunner

1. ____ The gunner spent his time scanning the sector assigned to him by his TC.

2. ____* The gunner assisted the TC in the navigation of the tank.

3. ____ The gunner helped locate landmarks to help in the navigation.

4. ____* The gunner ID'ed all targets as "green" enemy prior to opening fire.

5. ____ The gunner gave no verbal indication that he was intentionally engaging in or encouraging "risky" behavior.

6. ____ The gunner helped the TC with redistribution of ammo.

7. ____ The gunner did not fire on dead or disabled vehicles that would result in wasting ammo.

8. ____* The gunner did not shoot any friendly vehicles or aircraft.

RA Checklist for Navigation Training (Cont'd)

Please comment on the overall crew performance and willingness to work as a team. What were some of the crew comments on the exercise? Did they express any opinions on this at all? Where is the crew's most glaring weakness?

Training Notes

RESEARCH ASSISTANT CHECKLIST - CREW INTEGRATION TRAINING

Date: ____________ RA Name ______________

Sim Call # ____________ CONFIG: 3 4

CREW INTEGRATION TRAINING EXERCISE
(RA CHECKLIST)

Note to RAs: Put a plus (+) beside those statements that correctly describe this execution of the exercise and a minus (-) beside those items that do not correctly describe it. At the end of the crew training exercise, please ask the crew members questions about items with a minus (-) beside them and retrain if necessary. Remember that the main emphasis should be on the use of VIDS. First 2 events will be in Configuration 3 and second 2 events will be in configuration 4. Conduct any retraining during break between configuration change and before departing Sims after the last engagement. Complete one of these checklists per configuration.

TC:

1. ____ The TC was correctly located at the checkpoints when he reported being there.(+/-100-150m)
2. ____ The TC sent the correct type of reports (CONTACT or SPOT) at the appropriate times.
3. ____ The TC kept his mouth far enough away when he transmitted over the intercom/radio to be clearly understood.
4. ____ The TC briefed the gunner and driver on where they where going and what they could expect to encounter.
5. ____ The TC warned the gunner before he used the commander's override.
6. ____ The TC warned the crew prior to engaging a VIDS Semi or Automatic option.
7. ____ The TC successfully defeated OPFOR attacks using CMs and CF (if CF was activated).
8. ____ The TC successfully defeated ATGMs using the CMs.
9. ____ The TC followed the correct crew drills while using CMs and CF (if CF activated.
10. ____ The crew took the appropriate actions during a VIDS alert.

RA Checklist for Crew Training Exercise (Cont'd)

11. What is this crew's most glaring weakness with VIDS?

____

____

____

Driver

1. ____ The driver did not take unnecessary risks (i.e., drive into blue water) or run into other vehicles on purpose.

2. ____ The driver said "point" before reading the last digit of the odometer.

3. ____ The driver followed the TC's instructions on maneuvering the vehicle (i.e., avoiding ATGMs).

4. ____ The driver correctly identified at least one enemy vehicle.

5. ____ The driver took the correct actions in the crew battle drills.

Training Notes

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Gunner

1. ____ The gunner did not shoot at dead vehicles.

2. ____ The gunner scanned the area the TC instructed him to.

3. ____ The gunner correctly identified at least one enemy.

4. ____ The gunner took the correct actions upon a VIDS alert.

5. ____ The gunner fired battle sight when in the counterfire mode (after handoff from CF).

RA Checklist for Crew Training Exercise (Cont'd)

Training Notes

RESEARCH ASSISTANT CHECKLIST - PLATOON DEFENSIVE STX

Date: ____________ RA Name: ______________

Call Sign: ________

RA CHECKLIST
PLATOON TRAINING
DEFENSIVE STX

RA: Put a (+) next to those items that describe what the crew did and a (-) next to those items that do not describe what the crews actions. Put an "N/A" next to those items that were not applicable across the events within a particular vehicle configuration and mode of operation. During reconfiguration changes, retrain the crew on (-) items and/or talk to the crew about actions they should have taken. Refer to the Platoon Defensive STX Events List for threat events and when configuration and mode changes should occur. Before starting the next configuration, ensure the TC has set up the appropriate mode on his CCDP.

BASELINE CONFIGURATION, EVENTS 1 - 5.

Target Detection, Acquisition, and Engagement:

____ The TC assigned sectors to scan.

____ The TC alerted the crew (and/or the platoon) to the direction of the threat.

____ The gunner and/or driver alerted the crew to OPFOR.

____ The driver positioned the front of the tank toward the threat.

____ The TC alerted the crew before slewing the turret to the direction of the threat.

____ The gunner picked up the target(s) quickly once he was slewed to the general area.

____ The gunner was not pulled off of a target (i.e., complaint).

____ The TC and gunners used fire commands to engage threats.

____ The gunner lased prior to firing on the threat.

____ The TC called for fire on the OPFOR.

____ The driver maintained a steady platform while moving around.

Maneuver.

____ The TC had the driver move to avoid threat fires.

____ The driver maneuvered to find cover and avoid attack.

____ The TC and driver used terrain to obscure the tank.

____ The TC and driver used maneuver (or defilade) to evade ATGMs and protect his tank.

____ The driver aggressively maneuvered the tank with little or no guidance from the TC or gunner.

____ The TC used vehicle action drills.

Communication.

____ The TC reported CONTACT to his wingman, platoon leader, or Black 6.

____ The TC requested support from Black 6.

____ The TC sent a SPOT report after the end of an engagement.

Crew Integration.

____ Members of the crew did not "eat their mikes."

____ The crew executed battle drills well.

____ The crew worked together as a team.

Crew comments about this configuration, mode, equipment, and the events in this particular configuration:

RA CHECKLIST - DEFENSIVE STX (cont'd)

CONFIGURATION 1, SEMI MODE, EVENTS 6 - 10.

Target Detection, Acquisition, and Engagement:

____ The TC assigned sectors to scan.

____ The TC alerted the crew (and/or the platoon) to the direction of the threat.

____ The gunner and/or driver alerted the crew to OPFOR.

____ The driver saw the OPFOR before the VIDS alert and notified the TC and gunner.

____ The TC was alerted to the OPFOR location by the VIDS.

____ The TC used the icon location to help him locate the OPFOR for his crew, i.e., Tank, One O'Clock.

____ The TC warned the gunner before engaging the VIDS.

____ The driver positioned the front of the tank toward the threat.

____ The TC alerted the crew before slewing the turret to the direction of the threat.

____ The gunner picked up the target(s) quickly once he was slewed to the general area.

____ The gunner was not pulled off of a target (i.e., complaint).

____ The TC and gunner used fire commands to engage threats.

____ The gunner lased prior to firing on the threat.

____ The TC used the TGTSEL key to delete targets that were destroyed by counterfire (or defeated by CMs).

____ The TC called for fire on the OPFOR.

____ The driver maintained a steady platform while moving around.

____ The TC used countermeasures to protect the tank.

____ The TC did not confuse CCDP icons with the actual number of enemy.

____ After the OPFOR was found, the TC fought the tank and did not pay attention to the VIDS or options it provides.

RA CHECKLIST - DEFENSIVE STX (cont'd)

____ The TC did something very different with the CCDP. If so, explain what he did.

____

____

____

Maneuver.

____ The TC had the driver move to avoid threat fires.

____ The driver followed the TC's directions.

____ The TC used cover and concealment to add to his VIDS protection.

____ The TC used smoke effectively to obscure his vehicle.

____ The driver tried to use smoke to hide the tank.

____ The TC and driver used terrain for cover and concealment.

____ The TC and driver used maneuver (or defilade) to evade ATGMs and protect his tank.

____ The driver aggressively maneuvered the tank with little or no guidance from the TC or gunner.

____ The TC used vehicle action drills.

Communication.

____ The TC reported CONTACT to his wingman, platoon leader, or Black 6.

____ The TC requested support from Black 6.

____ The TC sent a SPOT report after the end of an engagement.

Crew Integration.

____ Members of the crew did not "eat their mikes."

____ The crew executed battle drills well.

____ The crew worked together as a team.

____ The crew took actions when they received a VIDS alert.

RA CHECKLIST - DEFENSIVE STX (cont'd)

Crew comments about this configuration, mode, equipment, and the events in this particular configuration:

RA CHECKLIST - DEFENSIVE STX (cont'd)

CONFIGURATION 2, AUTO MODE, EVENTS 11 - 15.

Target Detection, Acquisition, and Engagement:

____ The TC assigned sectors to scan.

____ The TC alerted the crew (and/or the platoon) to the direction of the threat.

____ The gunner alerted the crew to OPFOR.

____ The driver saw the OPFOR before the VIDS alert and notified the TC and gunner.

____ The TC was alerted to the OPFOR location by the VIDS.

____ The TC used the icon location to help him locate the OPFOR for his crew, i.e., Tank, One O'Clock.

____ The driver positioned the front of the tank toward the threat.

____ The TC alerted the crew before slewing the turret to the direction of the threat.

____ The gunner picked up the target(s) quickly once he was slewed to the general area.

____ The gunner was not pulled off of a target (i.e., complaint).

____ The TC and gunner used fire commands to engage threats.

____ The gunner lased prior to firing on the threat.

____ The TC used the TGTSEL key to delete targets that were destroyed by counterfire (or defeated by CMs).

____ The TC called for fire on the OPFOR.

____ The driver maintained a steady platform while moving around.

____ The TC did not confuse CCDP icons with the actual number of enemy.

____ After the OPFOR was found, the TC fought the tank and did not pay attention to the VIDS or options it provides.

RA CHECKLIST - DEFENSIVE STX (cont'd)

____ The TC did something very different with the CCDP. If so, explain what he did.

____

____

____

Maneuver.

____ The TC had the driver move to avoid threat fires.

____ The driver followed the TC's directions.

____ The TC used cover and concealment to add to his VIDS protection.

____ The TC used smoke effectively to obscure his vehicle.

____ The driver tried to use smoke to hide the tank.

____ The TC and driver used terrain for cover and concealment.

____ The TC and driver used maneuver (or defilade) to evade ATGMs and protect his tank.

____ The driver aggressively maneuvered the tank with little or no guidance from the TC or gunner.

____ The TC used vehicle action drills.

Communication.

____ The TC reported CONTACT to his wingman, platoon leader, or Black 6.

____ The TC requested support from Black.

____ The TC sent a SPOT report after the end of an engagement.

Crew Integration.

____ Members of the crew did not "eat their mikes."

____ The crew executed battle drills well.

____ The crew worked together as a team.

____ The crew took actions when they received a VIDS alert.

RA CHECKLIST - DEFENSIVE STX (cont'd)

Crew comments about this configuration, mode, equipment and the events in this particular configuration:

RA CHECKLIST - DEFENSIVE STX (cont'd)

CONFIGURATION 3, SEMI MODE, EVENTS 16 - 20.

Target Detection, Acquisition, and Engagement:

____ The TC assigned sectors to scan.

____ The TC alerted the crew (and/or the platoon) to the direction of the threat.

____ The gunner alerted the crew to OPFOR.

____ The driver saw the OPFOR before the VIDS alert and notified the TC and gunner.

____ The TC was alerted to the OPFOR location by the VIDS.

____ The TC used the icon location to help him locate the OPFOR for his crew, i.e., Tank, One O'Clock.

____ The TC warned the gunner before engaging the VIDS.

____ The driver positioned the front of the tank toward the threat.

____ The TC alerted the crew before slewing the turret to the direction of the threat.

____ The gunner picked up the target(s) quickly once he was slewed to the general area.

____ The gunner was not pulled off of a target (i.e., complaint).

____ The TC and gunner used fire commands to engage threats.

____ The gunner lased prior to firing on the threat.

____ The TC used the TGTSEL key to delete targets that were destroyed by counterfire (or defeated by CMs).

____ The TC called for fire on the OPFOR.

____ The driver maintained a steady platform while moving around.

____ The TC used countermeasures to protect the tank.

____ The TC did not confuse CCDP icons with the actual number of enemy.

____ After the OPFOR was found, the TC fought the tank and did not pay attention to the VIDS or options it provides.

RA CHECKLIST - DEFENSIVE STX (cont'd)

____ The TC did something very different with the CCDP. If so, explain what he did.

____

____

____

Maneuver.

____ The TC had the driver move to avoid threat fires.

____ The driver followed the TC's directions.

____ The TC used cover and concealment to add to his VIDS protection.

____ The TC used smoke effectively to obscure his vehicle.

____ The driver tried to use smoke to hide the tank.

____ The TC and driver used terrain for cover and concealment.

____ The TC and driver used maneuver (or defilade) to evade ATGMs and protect his tank.

____ The driver aggressively maneuvered the tank with little or no guidance from the TC or gunner.

____ The TC used vehicle action drills.

Communication.

____ The TC reported CONTACT to his wingman, platoon leader, or Black 6.

____ The TC requested support from Black 6.

____ The TC sent a SPOT report after the end of an engagement.

Crew Integration.

____ Members of the crew did not "eat their mikes."

____ The crew executed battle drills well.

____ The crew worked together as a team.

____ The crew took actions when they received a VIDS alert.

RA CHECKLIST - DEFENSIVE STX (cont'd)

Crew comments about this configuration, mode, equipment, and the events in this particular configuration:

RA CHECKLIST - DEFENSIVE STX (cont'd)

CONFIGURATION 4, AUTO MODE, EVENTS 21 - 25.

Target Detection, Acquisition, and Engagement:

____ The TC assigned crewmembers sectors to scan.

____ The TC alerted the crew (and/or the platoon) to the direction of the threat.

____ The gunner alerted the crew to OPFOR.

____ The driver saw the OPFOR before the VIDS alert and notified the TC and gunner.

____ The TC was alerted to the OPFOR location by the VIDS.

____ The TC used the icon location to help him locate the OPFOR for his crew, i.e., Tank, One O'Clock.

____ The driver positioned the front of the tank toward the threat.

____ The TC alerted the crew before slewing the turret to the direction of the threat.

____ The gunner picked up the target(s) quickly once he was slewed to the general area.

____ The gunner was not pulled off of a target (i.e., complaint).

____ The TC and gunner used fire commands to engage threats.

____ The gunner lased prior to firing on the threat.

____ The TC used the TGTSEL key to delete targets that were destroyed by counterfire (or defeated by CMs).

____ The TC called for fire on the OPFOR.

____ The driver maintained a steady platform while moving around.

____ The TC did not confuse CCDP icons with the actual number of enemy.

____ After the OPFOR was found, the TC fought the tank and did not pay attention to the VIDS or options it provides.

____ The TC did something very different with the CCDP. If so, explain what he did.

____

____

____

Maneuver.

____ The TC had the driver move to avoid threat fires.

____ The driver followed the TC's directions.

____ The TC used cover and concealment to add to his VIDS protection.

____ The TC used smoke effectively to obscure his vehicle.

____ The driver tried to use smoke to hide the tank.

____ The driver used terrain for cover and concealment.

____ The TC and driver used maneuver (or defilade) to evade ATGMs and protect his tank.

____ The driver aggressively maneuvered the tank with little or no guidance from the TC or gunner.

____ The TC used vehicle action drills.

Communication.

____ The TC reported CONTACT to his wingman, platoon leader, or Black 6.

____ The TC requested support from Black 6.

____ The TC sent a SPOT report after the end of an engagement.

Crew Integration.

____ Members of the crew did not "eat their mikes."

____ The crew executed battle drills well.

____ The crew worked together as a team.

____ The crew took actions when they received a VIDS alert.

RA CHECKLIST - DEFENSIVE STX (cont'd)

Crew comments about this configuration, mode, equipment and the events in this particular configuration:

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END OF STX ITEMS.

____ The TC expressed satisfaction in the VIDS equipment and feels the system made his job easier.

____ The TC feels the VIDS saved his tank most of the time.

____ The crew felt smoke (and flares) protected them.

Comments: ____

VIDS SME QUESTIONNAIRE

Date: __________ Name: ________________

Config: B 1 2 3 4

Using the scale below, rate each item to reflect your observations of the configuration during which **VIDS** was used.

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

1. _____ Maneuvering on the battlefield before contact
2. _____ Maneuvering on the battlefield during contact
3. _____ Ability to position weapon systems on the battlefield
4. _____ Target Acquisition (e.g., detection and identification)
5. _____ Target Engagement (e.g., accuracy and timeliness)
6. _____ Ability to mass fire on targets
7. _____ Maneuvering on the battlefield after contact
8. _____ Unit Performance
9. _____ Effectiveness of VIDS sensors and countermeasures:
   - a. _____ LWR+ (Enhanced Laser Warning Receiver)
   - b. _____ MWS+ (Enhanced Missile Warning Sensor)
   - c. _____ NIS (Non-Imaging System)
   - d. _____ FASR (Future Armored System Radar)
   - e. _____ TRWR (Tank Radar Warning Receiver)
   - f. _____ MCD (Missile Countermeasure Device)
   - g. _____ POMALS (Pedestal Operated Multi-Ammunition Launch System)
   - h. _____ MFD (Muzzle Flash Detector: part of TCS)
   - i. _____ CPS (Combat Protection System)
   - j. _____ LCMD (Laser Countermeasure Device)
   - k. _____ TCS (Threat Countermeasure System)

VIDS SME QUESTIONNAIRE

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

l. _____ Flares

m. _____ CF (CounterFire with main gun)

10. Please explain any "Below Average" or "Poor" ratings in Questions #1-8 regarding the use of VIDS (write Question # and letter, if appropriate beside comment):

____

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____

11. Did combat effectiveness improve with the use of VIDS? Please explain your answer.

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12. What benefits/problems did you observe regarding platoon maneuver and fires?

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VIDS SME QUESTIONNAIRE

13. What tactical changes might be made on the future battlefield if tanks were equipped with VIDS?

14. What configuration(s) (sensors and/or countermeasures) of VIDS were most effective? Why?

15. What other types of sensors or countermeasures do you think would be appropriate/effective? Why?

16. What guidance can you offer regarding the tactical use of sensors, countermeasures, and counterfire with VIDS?

17. In what tactical situations were each of the VIDS modes (semiautomatic or automatic) most effective? Why?

18. Was VIDS more useful in offensive or defensive situations? Explain your answer.

19. List at least three ways in which VIDS improved unit tactical performance.

20. What tactical, training, or soldier-machine interface problems do you foresee in using VIDS?

21. What new training requirements do you see associated with VIDS?

22. In what ways do you think the simulation environment (e.g., modeling of SAFOR) affected the outcomes of this evaluation?

Additional Comments:

VIDS RESEARCH ASSISTANT LOG

Note: Please get trial number from BattleMaster before starting each scenario. Also, use the Guidelines for the VIDS Capability Ratings for answering rating scales.

Date: ____________ Research Assistant: ____________________

Test Cycle: Pilot 1 2 3 4 Trial: ______________

Configuration (circle one):

Baseline	1	2	3	4
	LWR+ MWS+	LWR+ MWS+ NIS FASR	LWR+ MWS+ NIS FASR TRWR	LWR+ MWS+ NIS FASR TRWR
	MCD POMALS CF	MCD POMALS CF	MCD POMALS CF CPS	MCD CF CPS LCD FLARES

MODE: Automatic Semi-automatic

SCENARIO: A B C

SCENARIO EVENTS: For a list of the scenario events, refer to the scenario event list.

Simulator Role (circle one):

PLT LDR PLT SGT PL WING PS WING

VIDS RESEARCH ASSISTANT LOG

1. ***TC/Crew Interactions.*** The following items assess the quality and nature of crew interactions you observed during this scenario.

Record your observations of crew behaviors, such as adversarial interactions, expressions of frustration between crew members, level of confidence in the tank commander, etc.

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2. Please indicate your opinion of the overall nature of crew interactions observed during the scenario using the following five-point rating scale. Consider the observations you recorded above (circle one).

TC/Crew Interaction

1	2	3	4	5
Totally Incapable	Very Incapable	Somewhat Capable	Very Capable	Totally Capable

VIDS RESEARCH ASSISTANT LOG

3. ***Task Performance***. The following items assess individual task performance for the tank commander, gunner, and driver you observed during this scenario.

3a. Record your observations of **TANK COMMANDER** task performance. Include performance of tasks such as target detection, target identification, ammo redistribution, navigation, and communication.

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3b. Record your observations of **GUNNER** task performance. Include performance of tasks such as target detection, target identification, ammo selection, and communication.

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3c. Record your observations of **DRIVER** task performance. Include performance of tasks such as target detection, terrain use, and communication.

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____

3d. Please indicate your opinion of the overall crew capability, based on task performance you observed during the scenario, using the following five-point rating scale. Consider the observations you recorded above (circle one).

Crew Task Performance

1	2	3	4	5
Totally Incapable	Very Incapable	Somewhat Capable	Very Capable	Totally Capable

4. ***Equipment Usage.*** The following items assess equipment usage of the tank commander and gunner you observed during this scenario.

4a. Estimate the relative frequency of usage of vision blocks, GPSE and CCDP by the **TANK COMMANDER** you observed during this scenario.

Vision Blocks	GPSE	VIDS CCDP	
_____% +	_____ % +	_____ %	= 100%

4b. Did the Tank Commander want to change the mode or setup of the VIDS CCDP? ___ Yes ___ No

4c. If Yes, briefly describe his reasons.

____

____

____

4d. In **SEMI AUTOMATIC** mode, did the TC remember to engage the VIDS ACTIVATION BUTTON? ___ Yes ___ No ___ NA

4e. If No, indicate how often this occurred? ____

4f. Did the **TANK COMMANDER** fire the main gun? ___ Yes ___ No

4g. Use the following space to record your observations of crew reactions to the VIDS system. Include expressions of satisfaction or frustration by any crew members, confusion over sensings and countermeasures, or problems engaging the VIDS.

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____

4h. Please indicate your opinion of the overall crew equipment usage proficiency you observed during the scenario (circle one).

Crew Equipment Usage Proficiency

1	2	3	4	5
Totally Incapable	Very Incapable	Somewhat Capable	Very Capable	Totally Capable

5a. Crew Competence. Please indicate your opinion of the overall crew competence (how well they used equipment and performed all tasks) you observed during the stage (circle one).

Overall Crew Competence

1	2	3	4	5
Totally Incapable	Very Incapable	Somewhat Capable	Very Capable	Totally Capable

Appendix E

Appendix to Platoon SOP

VIDS Test
Appendix to Platoon SOP
Experiment-Specific Conditions

PURPOSE (supplements p.1, ¶ I).

To highlight specific exceptions to FKSM 17-15-3 (Feb 91) for the VIDS experiment. The paranthetical reference indicates whether the item supplements or replaces corresponding sections of the FKSM. The omission of a paragraph or section implies no exceptions to that portion of the standard SOP.

COMMAND AND CONTROL.

Organization (supplements p.1, ¶ II.a). 1st Plt: Manned simulators are provided for the Plt Ldr and Plt Sgt (tanks 1 and 4). The wing tanks are Semi-Automated Force vehicles. 2nd and 3rd Plts are entirely semi-automated.

Orders Group (replaces p.1, ¶ II.c).

Plt: All participants and BLUFOR operator.
A Company: Battlemaster, all participants, FIST, BLUFOR operator.

Security Readiness Conditions (REDCON) (replaces pp.3-5, ¶ II.f):

(1) REDCON - 1 (Full Alert). Unit ready to move immediately:

Simulator prepared for immediate tactical operations, to include: PMCS complete, radio nets open, VIDS operational in designated sensor, countermeasure and mode array.

(2) REDCON - 2 (Full Alert -- used just prior to scenario execution and for minor delays). Unit ready to move in 1-2 minutes:

(a) Prep for operations:

(1) Man simulators.
(2) Execute simulator pre-op checks.
(3) Open radio nets.
(4) Orient to terrain, verify formation.
(5) Place VIDS into operation.
(6) Submit BLUE - 11 (stand-to report).

(b) Report REDCON - 1 when ready to execute mission.

(c) On order, crew members stand by outside vehicle. Latrine calls authorized for no more than one crewman

per vehicle at a time.

(3) REDCON - 3 (Stand-by -- used for scenario breaks and when delays prevent mounting simulators to prepare for operations). Unit ready to move within 30 minutes:

(a) Dismount simulators, place crews on break: Latrine and smoke breaks authorized.

(b) Crews standing by in designated break area(s), prepared to mount simulators at designated time or on order.

(c) Access to simulators limited to test control and technical support personnel only.

(4) REDCON - 4 (Stand down -- used during exercise planning/prep and debriefings). Prepared to occupy simulators at specified time:

(a) Dismount simulators.

(b) Crews meet in classroom for briefings, debriefings, and off-vehicle preparation.

(c) Access to simulators limited to test control and technical support personnel only.

TACTICAL OPERATIONS.

<u>Operations Security</u> (supplements pp.5-6, ¶ III.a). Tactical radio nets used for the exercise scenarios model voice-secure systems. Fixed call signs (see the last page of this appendix) are used for simplicity. Authentication, when appropriate, will be accomplished administratively using participant's and control staff personnel's initials.

<u>Offensive Operations</u>.

Actions on contact (supplements p.19, ¶s III.g.(2) and III.g.(2)(a)). Initiate on visual detection of an enemy force, on VIDS alert, or when taking fire.

(a) Return fire and alert the platoon/company with a contact report. Implement active countermeasures as appropriate.

Battle Drills (supplements pp. 21-25, ¶ III.g.(3), sub-¶s (b),(c) and (e)).

(b) Contact Drills.

<u>1</u>. Platoon orients gun tubes in direction indicated and returns fire at identified targets. In absence of

identified targets, use VIDS display to orient turret.

2. Platoon continues to move and seek cover and concealment. Implement countermeasures as appropriate.

(c) Action Drills. Supplement visual detection with VIDS Commanders Control and Display Panel (CCDP) information to orient on enemy. Supplement natural cover and concealment with active VIDS countermeasures.

(e) Reaction to Artillery Attack. Simulators model the closed hatch condition at all times.

NBC Operations (supplements pp. 33-40, ¶ III.m). The NBC overpressure system is assumed on and functional in all situations. MOPP level zero (no protective gear worn or carried) is in effect at all times.

Basic Load (appended to ¶ III). The basic load for M1 simulators during the test is 27 Sabot (16 ready, 11 semi-ready) and 13 HEAT (6 ready, 7 semi-ready).

VIDS Set-Up (appended to ¶ III). The VIDS configuration for any training stage or test scenario will be specified by the Battle Master (or Co Cdr) in accordance with the training/test schedule. VIDS will be operated in the mode specified by the Co Cdr.

NOTE: For test control purposes, the VIDS sensor and countermeasure array and mode will remain constant throughout any given scenario.

SERVICE SUPPORT (supplements pp. 42, 44-47, D-13, -14, ¶s IV.b and f, and Yellow-2 report format). The only service support concerns relevant to the VIDS experiment are those directly related to the employment and consumption of main gun ammunition and smoke grenades. Service Support (e.g: resupply, reconstitution) operations will be accomplished administratively during and between scenarios, as appropriate. The Plt Ldr will submit Yellow and Red reports when appropriate. Use the following reference numbers for the ammo status report (Yellow 2):

Ref	Nomenclature
SABOT	Cartridge, 120 mm APFSDS-T, M829
HEAT	Cartridge, 120 mm HEAT-MP-T, M830
L8A1	Grenade, Smoke, L8A1 (visible)
M76	Grenade, Smoke, M76 (IR)

SOI Extract

Call Sign	Role/Function
CONTROL	Exercise Control (admin only)
Black 6	Co Cdr
Red 1	Test Plt Ldr
Red 4	Test Plt Sgt
Red 2	PLDR's wing
Red 3	PSG's wing

Call Sign	Role/Function
BRAVO	Co/Tm B
CHARLIE	Co/Tm C
DELTA	Co/Tm D
ECHO	Co E
Oscar	23rd AD
Papa	1st Bde/23d AD
Whiskey	2nd Bde/23d AD
Mike	146th AH Bn

Appendix F

Documentation for Scenario 1

Contents of Appendix F:

OPERATION ORDER

FP Evaluation: Opord 94-1

1. Situation.

a. Enemy.

(1) Overview: The 25th Guards Tank Division (GTD) has disengaged at PL Chain. Enemy is belived to be occupying hasty defensive positions north of PL Thrust. The purpose of the defense is to consolidate gains made during recent offensive operations. Friendly forces are no longer in contact with the enemy. The 140th MRR is believed to be occupying positions directly north of the battalion sector. The enemy security zone extends from PL Chain to PL Thrust. In the security zone, enemy forces will comprise of units company sized and below. The main defensive belt is beyond PL Thrust. There may also be units in security zone which are still in the process of withdrawing north to main defensive belt. In the main defensive belt, defenses will be organized around MRBs with T-80s used for reserves and counterattacks. Enemy is capable of achieving air superiority for limited periods of time.

(2) Composition and Disposition: The 25th GTD consists of the 1st TR (T-80), the 146th TR (T-80), and the 140th MRR (BMP-3). The overall strength of the 25th GTD is 75 - 80 percent.

(3) Most Probable Course of Action: Enemy continues defensive operations for next 24 hrs.

b. Friendly.

(1) Left: C Co.
(2) Right: B Co.
(3) Forward: TF Scouts.
(4) Reserve: D Co.
(5) Higher: TF Conducts movement to contact to re-establish contact with enemy. The TF will move in a wedge formation with A Co. in lead along Axis Storm. Engage and destroy all enemy forces in TF sector. Limit of advance is PL Thrust.

C. Terrain and Weather.

(1) Terrain. Rolling, steep wooded hills with deep ravines. Long north-south valley running length of TF sector with excellent fields of fire from front and flanks.

(2) Weather. Cool and clear. Temperature ranges from 62-74 degrees fahrenheit.

2. Mission. A Company crosses PL Chain at __________ and leads TF movement to contact to re-establish contact with enemy.

3. Execution.

a. Commander's Intent. My intent is to move rapidly, using scout observations, direct sightings, and vehicle sensors to find and fix enemy forces in sector. I want to destroy enemy platoon sized elements in sector. For enemy units larger than a platoon, I want to develop the situation enough to allow the TF Cdr the time needed to assess the situation and organize TF fire power to destroy the enemy.

b. Concept of the Operation.

(1) Maneuver. A Company will leave BP 01 in a wedge formation with 1st Plt in the front, 2nd Plt on the left, and 3rd Plt on the right. Until enemy contact, movement technique is travelling overwatch. After contact, movement technique is bounding overwatch using successive bounds. During bounding overwatch, 1st Plt will always take the lead, 2nd PLT will be the base of fire, and 3rd PLT will trail. Direction of attack is CP 3, 4, 8, 12, 13, 16, and 18.

(2) Fires. A Company has TF priorities of fires.

(3) ADA.

(a) WCS- Tight
(b) ADW- Yellow

c. Subordinate Instructions - SOP

d. Coordinating Instructions.

(1) Report PLs and CPs.
(2) Report all enemy contact.
(3) PIR

(a) T-80 Tanks
(b) Obstacle locations
(c) Enemy aircraft

4. Service Support. SOP

5. Command and Signal.

a. Command

(1) Cdr will be directly behind 1st Plt
(2) XO will be located to rear of 3rd Plt.
(3) Succession: XO, 2nd, 3rd, and 1st

b. Signal. Current SOI i/e.

SCENARIO 1 EVANT LIST

FP Evaluation: Opord 94-1
Scenario 94-1-B

Seq #	Label	Event	SAF Action	SAF Array
1	H	Plt reports REDCON I. Cdr orders Plt to wait	Threat Recon Plt crosses front	3 BRDM AT2
2	J	Plt ordered to cross LD/LC	AT Ambush	1 BRDM AT4
3	D	Plt ordered to recon ambush site	Air attack	1 HIND AT6
4	F	Plt ordered to occupy ambush site	Air attack	3 HIND AT6
5	B	Plt ordered to CP 12	Mtg Eng	3 T80 (Main Gun)
6	I	Plt ordered to cont. msn.	Air attack	2 HIND AT9
7	E	Plt occupies CP12. Scts report en. armor to front	En conducts company atk.	10 T80 (main gun)
8	G	Plt ordered to hold position.	En tank plt moves along rte 8	3 T80 (main gun)
9	C	Plt ordered to CP16	En conducts long range ambush	3 T80 AT11
10	A	Scts report BRDM Plt at CP16 cdr orders hasty atk	BRDM Plt defends CP!6	2 BRDM AT4

Appendix G

Soldier Completed Instruments

Contents of Appendix G:

VIDS BIOGRAPHICAL QUESTIONNAIRE

Name ______________________________ SSN _____-_____-______

Date __________ Sim Call Sign ______ Dty Pos: __________

1. Age _____ years
2. Current Army Rank __________
3. Current unit of assignment ______________________________
4. Military Specialty: 12A 12B 12C 19E 19K
   Other _________
5. Total time on active duty: ______ yrs/______ mos
6. List the units in which you have served on active duty:
   1) ____________________ _____ yrs/_____ mos
   2) ____________________ _____ yrs/_____ mos
   3) ____________________ _____ yrs/_____ mos
   4) ____________________ _____ yrs/_____ mos
7. List the type of vehicles on which you have served as a crewmember and how much experience you have had on each vehicle.
   a. type ____________________ _____yrs/_____ mos
   b. type ____________________ _____yrs/_____ mos
   c. type ____________________ _____yrs/_____ mos
   d. type ____________________ _____yrs/_____ mos
8. Indicate your present Duty Position in your current unit:

   ____

9. How much experience do you have in each of the following TO&E (combat maneuver unit) positions?

a. Driver _____ yrs/_____ mos h. Co XO _____ yrs/ _____mos

b. Loader _____ yrs/_____ mos i. Co Cdr _____ yrs/_____ mos

c. Gunner _____ yrs/_____ mos j. Bn S2 _____ yrs/_____ mos

d. Veh Cdr_____ yrs/_____ mos k. Bn S3 _____ yrs/_____ mos

e. Plt Sgt_____ yrs/_____ mos l. Bn Staff_____ yrs/_____ mos (S1, S4, BMO)

f. Plt Ldr_____ yrs/_____ mos m. Bn XO _____ yrs/_____ mos

g. Spec Plt Ldr _____ yrs/_____ mos n. Bn Cdr _____ yrs/_____ mos

10. Which of the following formal military courses have you completed? (check all that apply)

a. _____ PLDC d. _____ TCCC g. _____ AOAC

b. _____ BNCOC e. _____ SPLC h. _____ CAS3

c. _____ ANCOC f. _____ OBC i. _____ C&GSC

h. _____ Other ___________

11. How long has it been since you participated as a **trainee** in an actual field training exercise (**not counting NTC Staff training support**)? _______ mos

12. How many times have you participated as a member of a rotating unit in NTC or CMTC exercises? _______ times

13. How many days have you <u>previously</u> spent in CCTT/CATTC (SIMNET-T)? ______days. In the MWTB (previously CCTB or SIMNET-D)? _______ days
(if none, skip question 14)

14. In which of the following MWTB (CCTB or SIMNET-D) equipment evaluations have you participated? (check all that apply)

a. _____POSNAV b. _____IVIS c. _____CITV

d. _____CVCC (Co Level) e. _____CVCC (Bn TOC)

f. _____CVCC (Bn Level) g. _____Hollis Test

h. _____BSD i. _____X-ROD

j. Other__________________

15. Check your previous experience with computers (do not count SIMNET experience):

_____ no experience at all

_____ limited experience (ie. limited word processing or computer games)

_____ moderate experience (ie. some programming experience or frequent use of commercial computer programs)

_____ considerable experience (ie. fluent in more than one programming language or extensive experience using commercial programs such as spreadsheats)

16. People commonly report feeling uncomfortable using computers. Please circle below the value that best describes how you feel (in general) about using computers.

1	2	3	4	5
Very Uncomfortable		Neutral		Very Comfortable

17. Highest civilian education level:

_____ High School Diploma/GED

_____ Some College

_____ College Degree (BA/BS)

_____ Postgraduate work

VIDS BIOGRAPHICAL QUESTIONNAIRE

18. Total active duty time in combat maneuver units (for example, 194th AB, 2d AD): (Please list years/months)

    CONUS_____ yrs/_____ mos USAREUR_____ yrs/_____ mos
    KOREA_____ yrs/_____ mos SAUDI ARABIA_____yrs/_____ mos

19. Comments: Please provide any additional information regarding previous tranining or practical experience that may effect your performance

VIDS M1 VEHICLE COMMANDER'S TRAINING EVALUATION

Date __________ Simulator Call Sign ______

Duty Position (circle one): PL PSG PLW PSW

We are interested in your views about the training you received on the VIDS equipment. All responses are **confidential**.

Please indicate your opinions separately for each item using the following five-point rating scale:

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

1. How would you rate the components of the training program in preparing you to operate the VIDS?

CLASSROOM TRAINING:

a. Overall effectiveness of classroom sessions ______

b. Instructor's presentation ______

c. Viewgraphs ______

d. Handouts ______

e. Examples of tactical equipment use ______

VIDS DEMONSTRATIONS:

f. VIDS model demonstration ______

g. Large screen instruction (CCDP operations) ______

HANDS ON SIMULATOR TRAINING:

h. Hands-on training ______

i. RA explanations ______

HANDS ON VIDS TRAINING:

j. Hands-on training ______

k. Skills test ______

VIDS M1 VEHICLE COMMANDER'S TRAINING EVALUATION

Please explain any "Poor" ratings in Question #1 (list the letter beside your response).

____

____

____

____

Please indicate your opinion for each item using the following five-point rating scale:

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

2. How helpful was the basic information on how to operate the simulator? ______

3. How helpful were the tactical training exercises in preparing you to use the VIDS sensors and countermeasures in a tactical situation? ______

   a. Individual VIDS hands-on training ______

   b. Crew Integration Exercise ______

   c. Platoon Training Exercise (STX) ______

4. How helpful was the opportunity for hands on practice using the equipment during the events listed in Question #3? ______

   Please explain any "Below Average" or "Poor" ratings in Questions #2-4 (list Question # and, if appropriate, letter beside response).

   ____

   ____

   ____

   ____

VIDS M1 VEHICLE COMMANDER'S TRAINING EVALUATION

Please indicate your opinions separately for each item using the following five-point rating scale:

1	2	3	4	5
Very Unclear	Unclear	Neutral	Clear	Very Clear

5. Considering the training program as a whole, how clear were the following?

   a. Training objectives (what you were expected to learn) ______

   b. Information on how to operate the equipment ______

   c. Information on how to operate the equipment tactically ______

   d. Feedback on how well you were performing DURING TRAINING ______

   Please explain any "Not Clear" or "Not Very Clear" ratings for Question #5 (list the letter beside your response).

   ____

   ____

   ____

   ____

   ____

CONTINUE TO NEXT PAGE

VIDS M1 VEHICLE COMMANDER'S TRAINING EVALUATION

6. Now that you have been trained to use the VIDS CCDP and CCH, we would like you to help us understand how easy or difficult it is to learn to use these new pieces of equipment. Your views will assist training developers in planning the training that might eventually be provided to units who are transitioned to similar equipment in the future. Please review the functions listed and indicate how easy it was to learn each of them. Use the 5 point scale provided to rate each of the functions.

   Please indicate your opinion for each item using the following five-point rating scale:

1	2	3	4	5
Very Easy	Easy	Neutral	Difficult	Very Difficult

CCDP Functions:

_________ a. POWER FFK

_________ b. ENTER FFK (menus/programming)

_________ c. DSPLY FFK (declutters screen)

_________ d. TGTSEL FFK (target deletion)

_________ e. SCROLL FFKs (up/down for icons)

_________ f. MAIN FFK (return to main menu)

_________ g. NORM FFK (mode setup)

_________ h. Audible alerts (tones/messages)

_________ i. Threat Icon Symbols

_________ j. CM SELECT Field

_________ k. CM STORES Field

_________ l. THREAT COORDINATE Field

_________ m. Alert Indicator

_________ n. Tank Icon (Turret/Hull Reference)

_________ o. Sectors

VIDS M1 VEHICLE COMMANDER'S TRAINING EVALUATION

CCH Function:

________ p. VIDS Activation Button (semi-automatic mode only)

VIDS Functions Overall:

________ q. Using semi-automatic mode

________ r. Using automatic mode

________ s. Performing main gun counterfire (including target hand-off)

________ t. Deleting icons after counterfire (to return to VIDS operation)

7. Please provide any additional comments you might have on ease of learning.

____

____

____

____

____

CONTINUE TO NEXT PAGE

8. We are interested in how much time is required for tank commanders to become fully proficient in using all functions of the VIDS CCDP and CCH. Based on your experience with our training program, do you feel training time in an evaluation like this should be increased or decreased? Please rate classroom and individual hands-on training separately. For each listed item, place the number from the scale which best reflects your opinion, in the appropriate column. For example, if you feel that classroom training time for a particular function should be decreased by half (compared the time spent in this evaluation), enter "2" in the CLASSROOM column next to that function.

Less Time 1	2	3	4	5	More Time 6
¼ As Much	½ As Much	No Change	¼ As Much Again	½ As Much Again	Twice As Much Again

CCDP Functions:	CLASSROOM	INDIVIDUAL
a. POWER FFK	______	______
b. ENTER FFK (menus/programming)	______	______
c. DSPLY FFK (declutters screen)	______	______
d. TGTSEL FFK (target deletion)	______	______
e. SCROLL FFKs (up/down for icons)	______	______
f. MAIN FFK (return to main menu)	______	______
g. NORM FFK (mode setup)	______	______
h. Audible alerts (tones/messages)	______	______
i. Threat Icon Symbols	______	______
j. CM SELECT Field	______	______
k. CM STORES Field	______	______
l. THREAT COORDINATE Field	______	______
m. Alert Indicator	______	______
n. Tank Icon (Turret/Hull Reference)	______	______

	CLASSROOM	INDIVIDUAL
o. Sectors	_______	_______
CCH Function:		
p. VIDS Activation Button (semi only)	_______	_______
VIDS Functions Overall:		
q. Using semi-automatic mode	_______	_______
r. Using automatic mode	_______	_______
s. Performing main gun counterfire (including target hand-off)	_______	_______
t. Deleting icon after counterfire (to return to VIDS operation)	_______	_______

9. a. Using the same scale, please indicate the training time needed overall to become proficient at the individual, crew, and platoon levels.

Individual VIDS Training _____

Crew Training (with VIDS) _____

Platoon Training _____

b. Please provide any additional comments you might have on training time needed.

____

____

____

10. Were there any VIDS functions that you didn't use during the Crew Integration Exercise or Situational Training Exercise (STX)?

Yes _____ No_____ If yes, which ones and why?

____

____

____

VIDS M1 VEHICLE COMMANDER'S TRAINING EVALUATION

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

11. Using the scale above, how would you characterize your level of preparation in performing the tasks required during the Platoon STX? _____

12. Please identify those tasks which you were not adequately prepared to perform in the Platoon STX exercise and explain.

____

____

____

____

13. Did the classroom instructor provide enough information about the operational concepts underlying the new equipment?

Yes _____ No _____ If no, please explain.

____

____

____

____

____

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

14. Using the scale above, how would you rate the quality of the Platoon STX Debrief? _____

CONTINUE TO NEXT PAGE

15. Please explain your ratings of the debriefings.

____

____

____

____

____

16. Please provide any other comments that would help us understand how you feel about the quality of training you received.

____

____

____

____

____

17. What suggestions do you have on how to improve the training program?

____

____

____

____

____

CONTINUE TO NEXT PAGE

18. Now that you have been trained on the VIDS we would like to take it one step further. Suppose that you are asked to become a member of a New Equipment Training Team (NETT) and this team has the mission to develop the transition training, the program of instruction (POI), and to teach these new tasks to tankers already trained on the M1. How much time do you think would be needed to train the necessary skills to operate the tank in the field? For each task listed below, indicate your opinion by writing in the time required.

Please only write times from 15 minutes to 8 hours, in 15 minute increments. For example, if you think it would take two and a quarter hours to train a particular task, write "2¼" in the space for that task.

USING THE VIDS

HOURS

________ a. Sense and determine relative direction of threats.

________ b. Identify and determine the most dangerous threats.

________ c. Avoid and counter threat munitions.

________ d. Counter and defeat threat platforms.

________ e. Perform integrated crew operations.

________ f. Tactically maneuver at the platoon level.

________ g. Prepare battlefield reports (with CCDP information).

19. Please provide any additional comments you might have on training time for new equipment.

____

____

____

____

CONTINUE TO NEXT PAGE

20. Again assume that the VIDS is being fielded and you are a member of the New Equipment Training Team (NETT). This team has the mission to develop the transition training, the program of instruction (POI), and to teach these new tasks to tankers already trained on the M1. Do you think simulators provide adequate training in such a situation?

For each task listed below, place a check mark under **SIMULATOR** if you think that the task can be adequately trained in simulators like SIMNET and UCOFT. If you think the tasks could be better trained on a real tank, place a check mark under **REAL TANK**. Check both columns if you think a combination is necessary.

USING THE VIDS	SIMULATOR	REAL TANK
a. Determine relative direction of threats.	________	________
b. Identify and determine the most dangerous threats.	________	________
c. Avoid and counter threat munitions.	________	________
d. Counter and defeat threat platforms.	________	________
e. Perform integrated crew operations.	________	________
f. Tactically maneuver at the platoon level.	________	________
g. Prepare battlefield reports (using CCDP information.	________	________

21. For those tasks which you have check REAL TANK. please write the number of the task as it appears on the questionnaire and briefly tell us why you made that choice in the space provided below.

____

____

____

VIDS M1 VEHICLE COMMANDER'S TRAINING EVALUATION

22. Please provide any additional comments you might have on types of training for new equipment:

____

____

____

____

____

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

23. Using the scale above, how would you rate the potential contribution of using Semi-Automated (SAFOR) as a training tool? _____

24. Please explain your rating of SAFOR as a potential training tool.

____

____

____

____

25. Additional comments (include comments regarding equipment here):

____

____

____

____

____

PT 59-54A

VIDS M1 GUNNER'S TRAINING EVALUATION

Date: __________ Sim Call Sign: ______ Duty Pos: Gunner

We would like your opinion of the training you received and the equipment you used during the past week. Your responses are **confidential.**

Please indicate your opinions below using the five-point scale provided.

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

1. How would you rate the components of the training program in preparing you to operate the Simulator?

   _____ a. Classroom instruction

   _____ b. Hands-on instruction

   _____ c. Training exercises

   Please explain any "Below Average" or "Poor" ratings in Question #1 (list the letter beside your response).

   ____

   ____

   ____

   ____

2. Do you feel the roundtable discussion with gunners and drivers helped you to better understand the operation and tactical implications of the VIDS? Why or why not?

   ____

   ____

   ____

   ____

3. What other comments do you have that would help us understand how you feel about the quality of training you received?

PT 59-54B

VIDS M1 DRIVER'S TRAINING EVALUATION

Date: __________ Sim Call Sign: ______ Duty Pos: Driver

We would like your opinion of the training you received and the equipment you used during the past week. Your responses are **confidential**.

Please indicate your opinions below using the five-point scale provided.

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

1. How would you rate the components of the training program in preparing you to operate the Simulator?

   _____ a. Classroom instruction

   _____ b. Hands-on instruction

   _____ c. Training exercises

   Please explain any "Below Average" or "Poor" ratings in Question #1 (list the letter beside your response).

   ____

   ____

   ____

   ____

2. Do you feel the roundtable discussion with gunners and drivers helped you to better understand the operation and tactical implications of the VIDS? Why or why not?

   ____

   ____

   ____

   ____

3. What other comments do you have that would help us understand how you feel about the quality of training you received?

Workload Assessment

PLATOON LEADER

Date: ______________

ID Number: _________

Definitions of Workload Assessment Subscales

The purpose of this Workload Assessment questionnaire is to document the workload associated with these tasks. The results will be used to identify workload effects on soldier task performance associated with operating this equipment, so please answer carefully. Please refer to the six subscale definitions below before providing a rating.

SUBSCALE	DEFINITION
Mental Demand	Mental activity required. This includes tasks that require thought, decisions, calculations, memory, searching, and others. did you consider the tasks easy or difficult, simple or demanding, precise or general?
Physical Demand	Body movement required. This includes tasks that require pushing, pulling, sliding, controlling. Did you consider the tasks slack or strenuous, easy or laborious?
Time Demand	Time pressure associated with completion of tasks. Was the pace slow or rapid? Did the tasks require continual deadlines or permit slack periods?
Performance	Success. How successful were you in doing what was required and how satisfied were you in what you accomplished?
Effort	Expenditures. How much energy did you have to expend to complete the tasks? Very little effort or continual drain of your resources?
Frustration	Paybacks of tasks. Did you consider your attitude toward the tasks as secure or insecure, gratified or discouraged, relaxed or stressed?

Rate the scale by marking an **X** in one of the fields of the scale. **PLEASE MARK ON THE VERTICAL LINES. DO NOT MARK IN BETWEEN THE VERTICAL LINES.**

Workload Assessment

ID Number: ________
Duty Position: PLT LDR

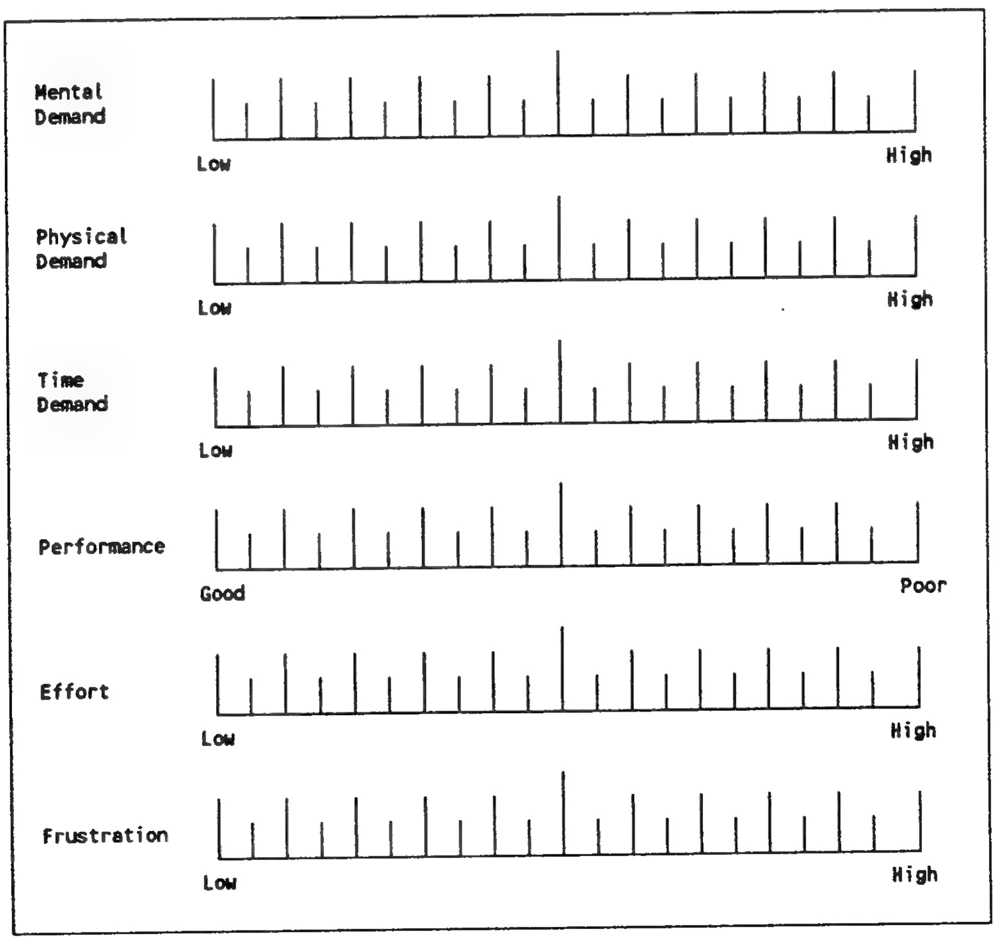
Task: Coordinate Sector Searches

Task Definition:
- Determine sector widths and direction
- Designate sectors to vehicles
- Modify searches in response to tactical situation

Did you perform this task? Yes ____ No ____

If you answered NO, skip this page.

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



Workload Assessment

ID Number: ________
Duty Position: PLT LDR

Task: Direct Platoon Maneuver

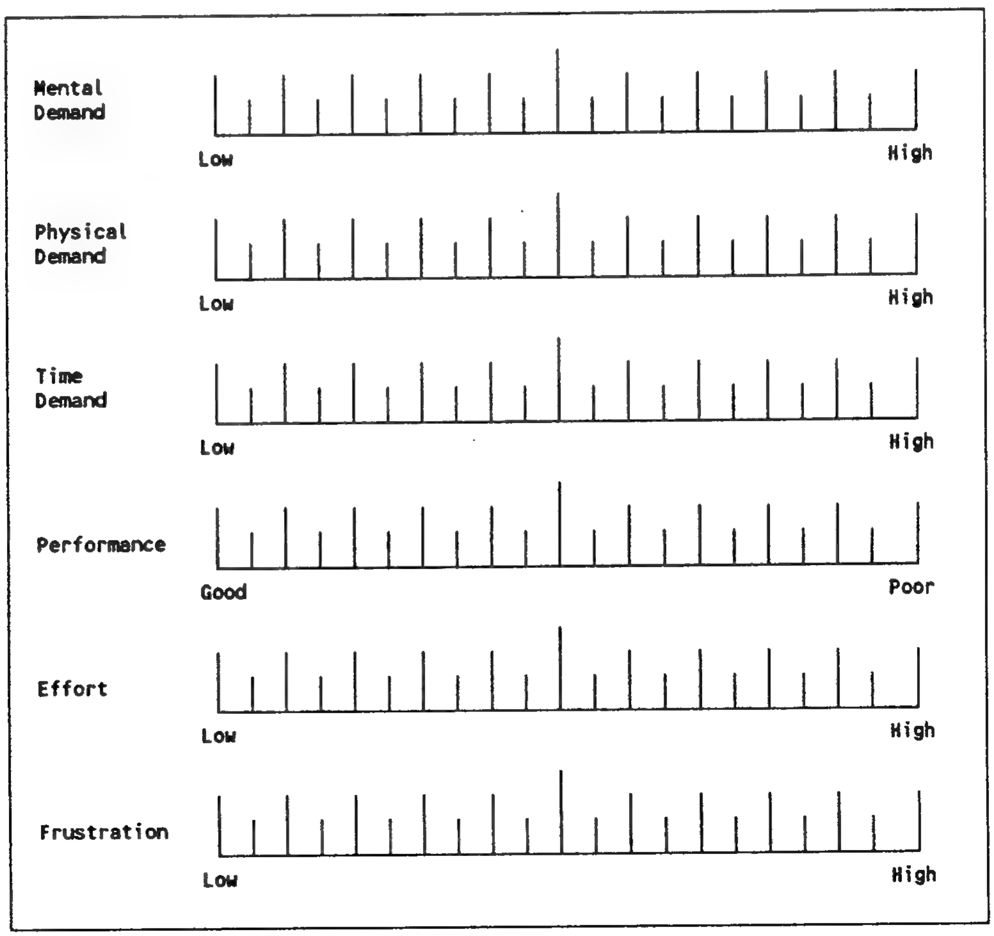
Task Definition:

- Direct and monitor formations
- Monitor security, dispersion, speed, and avenues of movement
- Coordinate movement and fires
- Modify planned movement as required
- Communicate corrective actions to subordinate

Did you perform this task? Yes ____ No ____

If you answered NO, skip this page.

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



Workload Assessment

ID Number: ________
Duty Position: PLT LDR

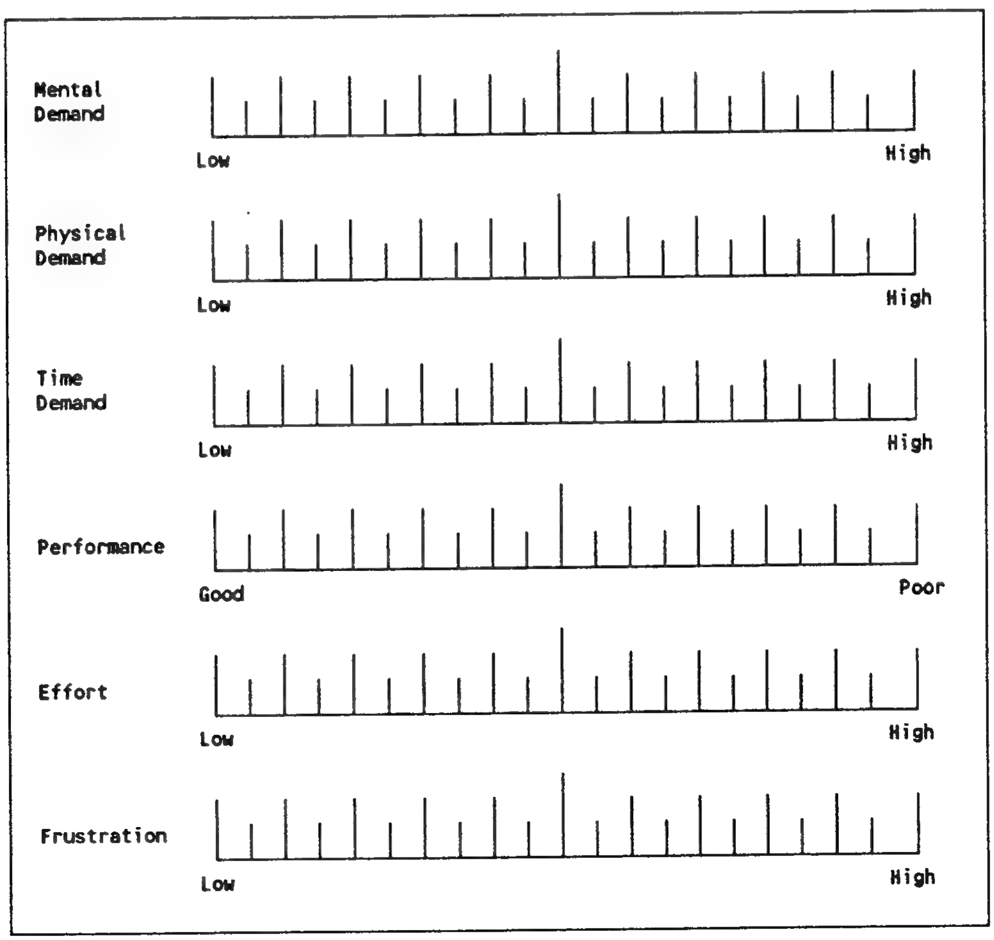
Task: Direct Platoon Fires

Task Definition:

- Alert platoon or section for fire
- Select ammunition
- Describe targets (the type, number, and activity
- Orient platoon to location
- Control fire patterns or technique (optional)
- Execute fires
- Cease or continue engagement

Did you perform this task? Yes ____ No ____
(If you answered NO, skip this page.)

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



Workload Assessment

VEHICLE COMMANDER

Date: ______________

ID Number: _________

Definitions of Workload Assessment Subscales

The purpose of this Workload Assessment questionnaire is to document the workload associated with these tasks. The results will be used to identify workload effects on soldier task performance associated with operating this equipment, so please answer carefully. Please refer to the six subscale definitions below before providing a rating.

SUBSCALE	DEFINITION
Mental Demand	Mental activity required. This includes tasks that require thought, decisions, calculations, memory, searching, and others. did you consider the tasks easy or difficult, simple or demanding, precise or general?
Physical Demand	Body movement required. This includes tasks that require pushing, pulling, sliding, controlling. Did you consider the tasks slack or strenuous, easy or laborious?
Time Demand	Time pressure associated with completion of tasks. Was the pace slow or rapid? Did the tasks require continual deadlines or permit slack periods?
Performance	Success. How successful were you in doing what was required and how satisfied were you in what you accomplished?
Effort	Expenditures. How much energy did you have to expend to complete the tasks? Very little effort or continual drain of your resources?
Frustration	Paybacks of tasks. Did you consider your attitude toward the tasks as secure or insecure, gratified or discouraged, relaxed or stressed?

Rate the scale by marking an **X** in one of the fields of the scale. **PLEASE MARK ON THE VERTICAL LINES. DO NOT MARK IN BETWEEN THE VERTICAL LINES.**

Workload Assessment

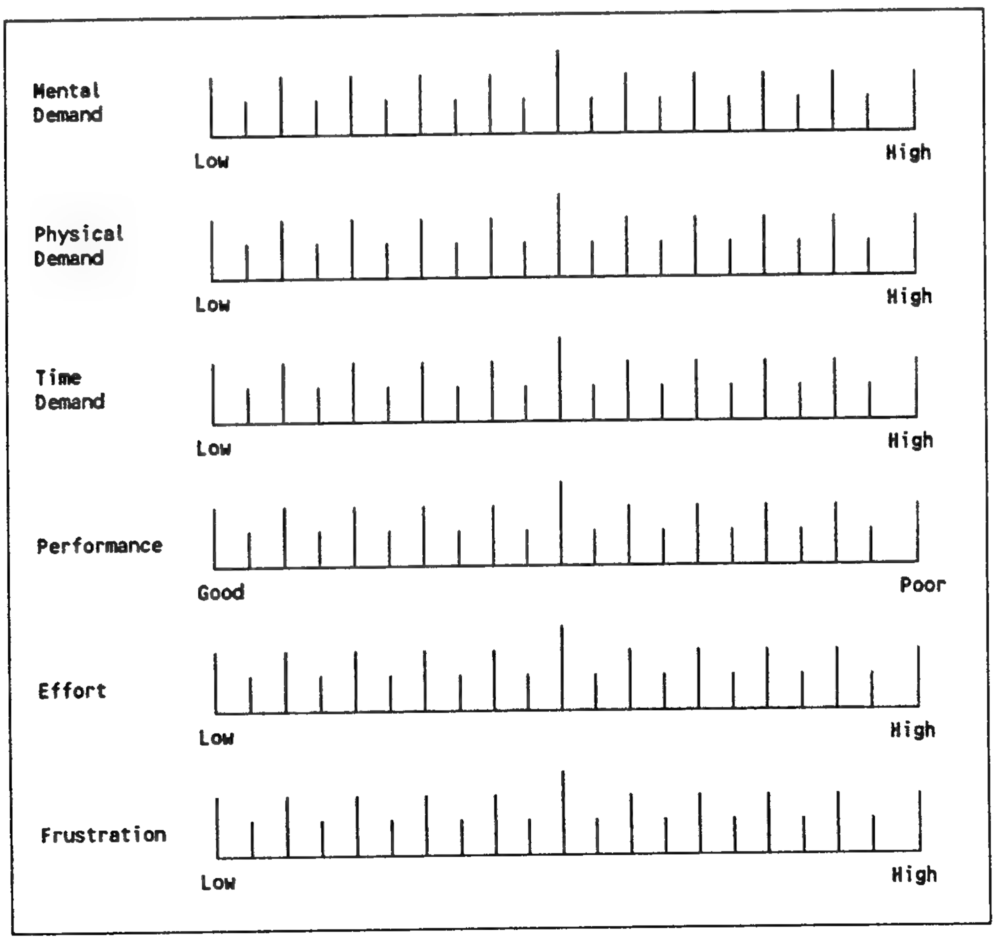
ID Number: ________
Duty Position: (Circle One) PLT LDR PLT SGT PL Wing PSG Wing

Task: Acquire Targets

Task Definition:
- Perform sector searches
- Detect targets
- Locate targets
- Identify targets
- Classify priority of targets (most to least dangerous)
- Confirm target status (enemy, friendly, neutral, doubtful)

Did you perform this task? Yes ____ No ____
If you answered NO, skip this page.

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



Workload Assessment

ID Number: ________
Duty Position: (Circle One) PLT LDR PLT SGT PL Wing PSG Wing

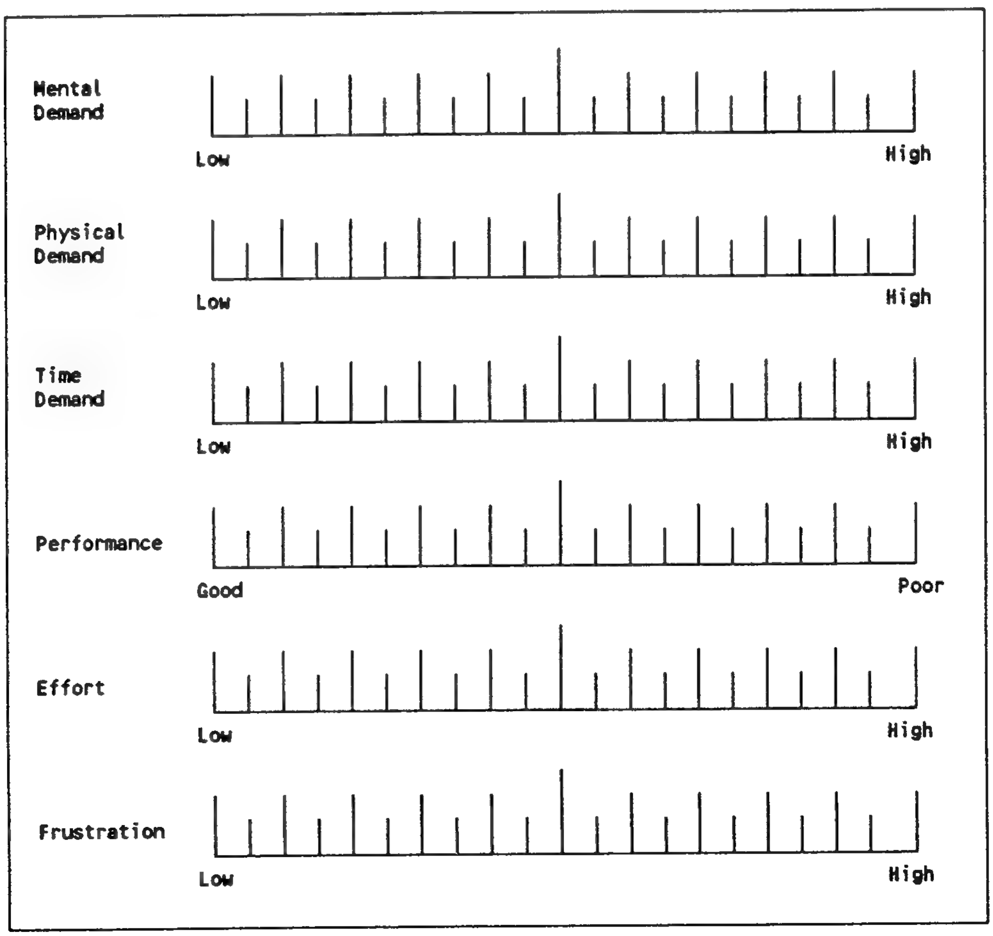
Task: Engage Targets

Task Definition:
- Select and prioritize targets
- Determine TC or gunner actions (including target handoff)
- Issue fire commands
- Observe fires
- Continue or cease engagement

Did you perform this task? Yes ____ No ____

If you answered NO, skip this page.

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



Workload Assessment

ID Number: ________
Duty Position: (Circle One) PLT LDR PLT SGT PL Wing PSG Wing

Task: Evade ATGMs

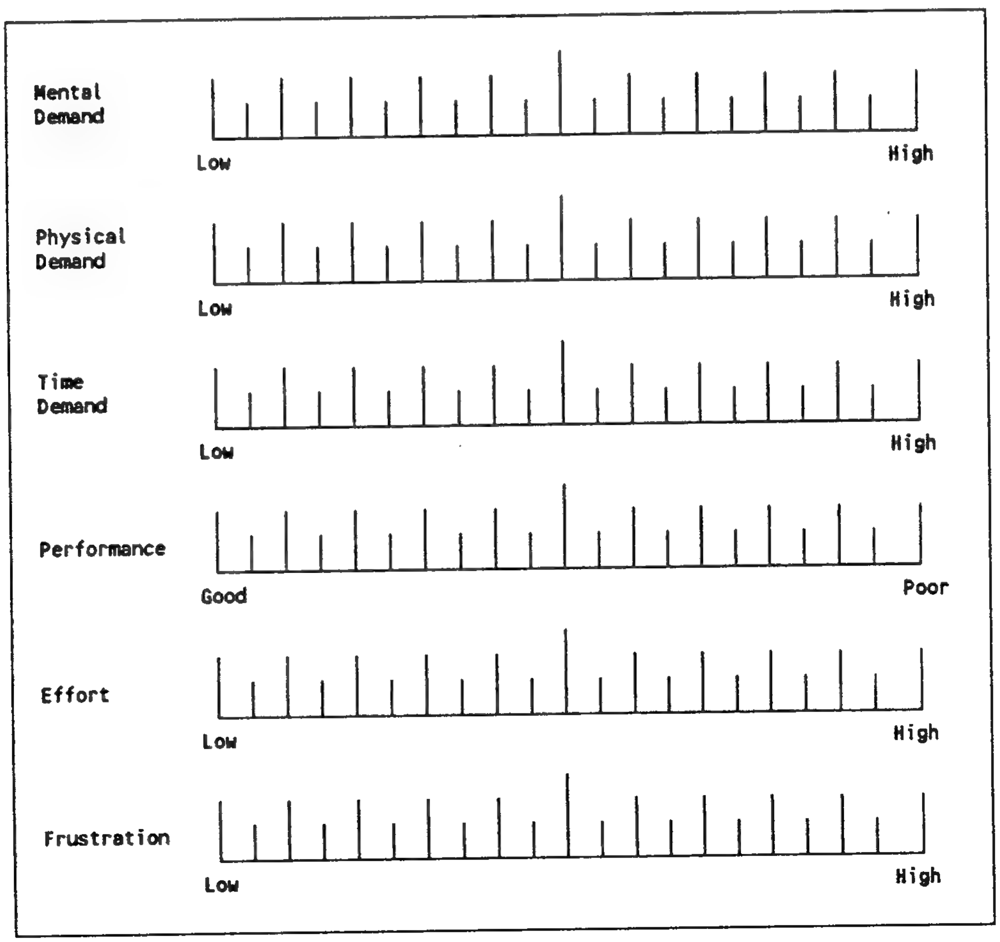
Task Definition:

- Alert crew to missile signature
- Give direction
- Direct driver in maneuvering tank (to evade ATGMs)
- Search for cover and concealment
- Issue fire commands (if appropriate)
- Report actions

Did you perform this task? Yes ____ No ____

If you answered NO, skip this page.

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



Workload Assessment

ID Number: ________
Duty Position: (Circle One) PLT LDR PLT SGT PL Wing PSG Wing

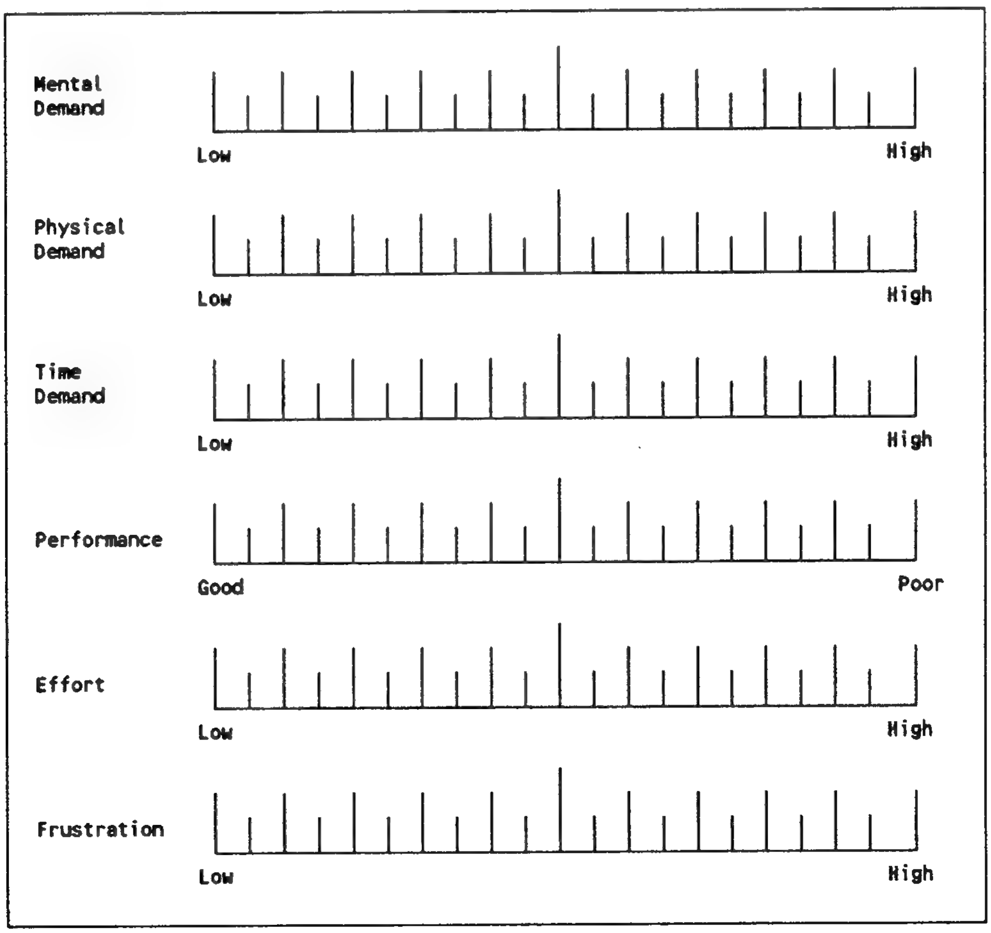
Task: Prepare and Send CONTACT Report

Task Definition:
- Observe enemy contact
- Determine essential information (e.g., number, location) for report
- List information or compose report
- Send (transmit) report

Did you perform this task? Yes ____ No ____

If you answered NO, skip this page.

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



Workload Assessment

ID Number: ________
Duty Position: (Circle One) PLT LDR PLT SGT PL Wing PSG Wing

Task: Prepare and Send SPOT Report

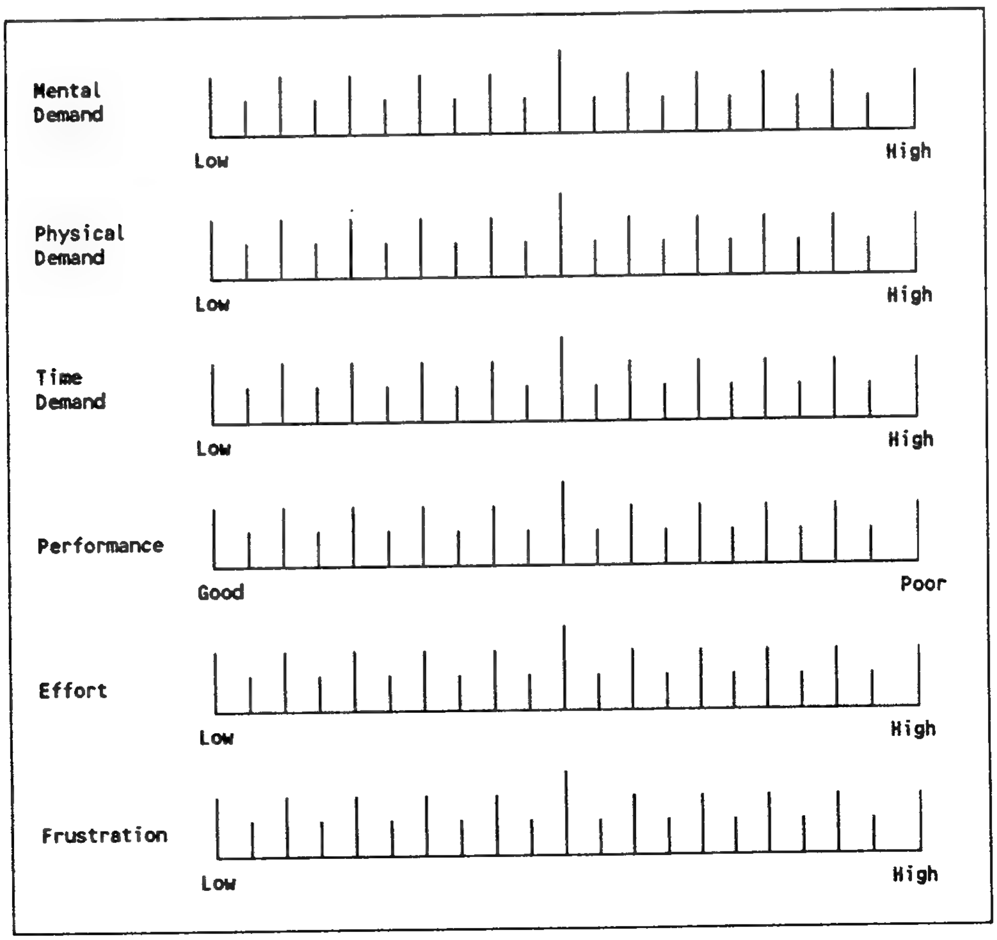
Task Definition:

- Observe enemy activity or reportable information about the area of operations
- Determine essential information (e.g., what, where) for report
- List information or compose report
- Send (transmit) report

Did you perform this task? Yes ____ No ____

If you answered NO, skip this page.

If you answered YES, consider all your experiences performing this task during the scenario exercises. Please provide an overall (average) workload rating for this task using the scales below.



VIDS SOLDIER-MACHINE INTERFACE QUESTIONNAIRE

The purpose of the SMI questionnaire is to document the strengths and weaknesses of the VIDS equipment. The results will be used to identify improvements for the system and to guide development efforts, so please answer as accurately as possible.

You will be asked to rate the acceptability of different features of the equipment. Acceptability may mean something different for each person responding to the questionnaires. To try to make that concept mean the same thing for each of you, we would like you to use the following definition of acceptability when responding to individual items.

Something is ACCEPTABLE if it:

- **Enables you to perform your job**
- **Is easy to learn**
- **Is easy to use**
- **Is not confusing.**

Before rating an item I would like you to consider these four aspects of acceptability and make your rating accordingly. Refer back to this cover sheet, if necessary.

If a feature does not "measure up" on any of these aspects, I would like you to tell us about it. Space is provided after each rating for your comments.

For example:

__2__ Understandability of labels (i.e., TGTSEL)

I couldn't remember what TGTSEL stands for.

You will be rating acceptability on a 5-point scale. Please only use whole numbers: 1, 2, 3, 4 or 5.

Do you have any questions?

VIDS SOLDIER-MACHINE INTERFACE QUESTIONNAIRE

Date __________ Simulator Call Sign ______

Duty Position (circle one): PL PSG PLW PSW

Please indicate your opinion about the acceptability of each feature of the VIDS CCDP interface using the following five-point rating scale. Please write any comments you have concerning an item directly below it.

1	2	3	4	5
Totally Unacceptable	Partially Unacceptable	Neutral	Partially Acceptable	Totally Acceptable

GENERAL VIDS FUNCTIONS

1. _____ Location of the CCDP in the simulator

2. _____ Graphic quality of information on CCDP (e.g., letters are large enough, lines are distinct, etc.)

3. _____ Touch Screen input

4. _____ Control Handle

5. _____ Color coding of screen

FIXED FUNCTION KEYS (FFKS)

6. _____ Arrangement of keys on screen

7. _____ Size of keys

8. _____ Number of keys

9. _____ Understandability of labels (i.e., TGTSEL)

10. _____ Responsiveness of keys after touching

PROGRAMMABLE FUNCTION KEYS (PFKS)

11. _____ Location of keys on screen

12. _____ Labelling of keys

13. _____ Touching ENTER key to activate programmable keys

14. _____ Understandability of menu hierarchy

VIDS SOLDIER-MACHINE INTERFACE QUESTIONNAIRE

1	2	3	4	5
Totally Unacceptable	Partially Unacceptable	Neutral	Partially Acceptable	Totally Acceptable

15. _____ Ability to identify the menu in which you are operating

SECTORS

16. _____ Number of sectors on display screen
17. _____ Ease of understanding the function of sectors
18. _____ Ease of identifying different sectors

INFORMATION DISPLAYS

19. _____ Amount of information in "CM SELECT" field
20. _____ Understandability of information in "CM SELECT"
21. _____ Amount of information in "CM STORES" field
22. _____ Understandability of information in "CM STORES"
23. _____ Amount of information in Threat Coordinates field
24. _____ Understandability of information in Threat Coordination Field.
25. _____ Understandability of information in Mode Indicator
26. _____ Threat icons
27. _____ Ability to scroll through threat information
28. _____ Overall clarity of information
29. _____ Overall amount of information presented
30. _____ Priority of threat information

ALERT SIGNALS

31. _____ Auditory alert signals
32. _____ Voice message alerts

VIDS SOLDIER-MACHINE INTERFACE QUESTIONNAIRE

1	2	3	4	5
Totally Unacceptable	Partially Unacceptable	Neutral	Partially Acceptable	Totally Acceptable

33. _____ Error message alerts (e.g. RND TYPE EMPTY)

COUNTERFIRE

34. _____ Touching TGTSEL FFK to signal end of engagement and return to VIDS system for next threat

ICON DELETION

35. _____ Automatic deletion of inactive threat icon (after 30 seconds)

36. _____ Manual deletion (using SCROLL and TGTSEL FFKs)

AUTOMATIC MODE

37. _____ Prioritization of threats

38. _____ Main gun automatically slewing to threat vicinity

39. _____ VIDS choice of countermeasure

SEMI-AUTOMATIC MODE

40. _____ Engaging thumb switch for activation of countermeasures and counterfire

41. _____ Your ability to control VIDS

42. _____ Amount of time to react to threat warning

CONTINUE ON NEXT PAGE

43. Describe three things you would change about the VIDS CCDP display.

1) ______________________________

____

2) ______________________________

____

3) ______________________________

____

44. Describe three ways you would change the countermeasure devices.

1) ______________________________

____

2) ______________________________

____

3) ______________________________

____

45. Describe three ways in which you would change the threat warning system of VIDS (e.g., prioritization).

1) ______________________________

____

2) ______________________________

____

3) ______________________________

____

46. Describe three ways in which you would change counterfire.

1) ____

____

2) ____

____

3) ____

____

47. Did the VIDS system increase or decrease your stress level (i.e., level of anxiety)? Explain.

1) ____

____

2) ____

____

3) ____

____

48. Please rank the functional configurations (baseline and VIDS) from 1 to 5, where 1 is your most preferred, and 5 is your least preferred. Do not leave any item blank or mark any two items with the same rank. **(Refer to configuration table on next page.)**

______ Baseline, no VIDS configuration

______ LWR, MWS+, MCD, POMALS, and CF

______ LWR, MWS+, NIS, FASR, MCD, POMALS, and CF

______ LWR, MWS+, NIS, FASR, TRWR, MCD, POMALS, CPS, and CF

______ LWR, MWS+, NIS, FASR, TRWR, MFD, CPS, LCMD, TCS, Flares, and CF

VIDS SOLDIER-MACHINE INTERFACE QUESTIONNAIRE

Please refer to this configuration summary before answering the previous question.

LWR, MWS+, MCD POMALS, CF	In this configuration, VIDS detects laser emissions (with LWR) and missile launch signatures (with MWS+). Only laser threats directed at the VIDS-equipped vehicle are detected. Audible alert tones are sounded and threat icons are displayed on the CCDP when VIDS detects an enemy laser emission (LRF, LBR, or LD) or detects a missile launch. VIDS can respond to any detected threat using MCD (to jam incoming missiles), POMALS (smoke grenades to disrupt incoming IR-guided missiles or provide cover), or Counterfires (CF) (to align the main gun with the threat) in semiautomatic or automatic mode.
LWR, MWS+, NIS, FASR, MCD, POMALS, CF	In this configuration, VIDS detects laser emissions (with LWR), missile launch signatures (with MWS+), acoustic signature of rotary aircraft (with NIS), and bearing/speed/location of ground and air platforms (with FASR). Only laser threats directed at the VIDS-equipped vehicle are detected. Audible alert tones are sounded and threat icons are displayed on the CCDP when VIDS detects an enemy laser emission (LRF, LBR, or LD) or detects a missile launch. Voice messages are delivered when helicopters are detected or identified. Icons are displayed on the CCDP when the VIDS radar detects, classifies, and tracks ground or air platforms entering its sector range. VIDS can respond to any detected threat using MCD (to jam incoming missiles), POMALS (smoke grenades to disrupt incoming IR-guided missiles or provide cover), or CF (to align the main gun tube with the threat) in semiautomatic or automatic mode.
LWR, MWS+, NIS, FASR, TRWR, MCD, POMALS, CPS, CF	In this configuration, VIDS detects laser emissions (with LWR), missile launch signatures (with MWS+), acoustic signatures of rotary aircraft (with NIS), radar emissions (with TRWR), bearing/speed/location of ground and air platforms (with FASR), and optical sighting systems (CPS). Only laser threats directed at the VIDS-equipped vehicle are detected. Audible alert tones are sounded and threat icons are displayed on the CCDP when VIDS detects an enemy laser emission (LRF, LBR, or LD) or detects a missile launch. Voice messages are delivered when helicopters are detected or identified. Ground and air platform icons are displayed on the CCDP when threat radar emissions strike the VIDS-equipped vehicle or VIDS radar detects, classifies, and tracks ground or air platforms in its sector range. VIDS can respond to any detected threat using MCD (to jam incoming missiles, POMALS (smoke grenades to disrupt incoming IR-guided missiles or provide cover), CPS (to disrupt optical tracking systems), or CF (to align the main gun tube with the threat) in semiautomatic or automatic mode.
LWR, MWS+, NIS, FASR, TRWR, MFD, LCMD, TCS, Flares, CF	In this configuration, VIDS detects laser emissions (with LWR), missile launch signatures (with MWS+), acoustic signatures of rotary aircraft (with NIS), radar emissions (with CPS, TRWR), bearing/speed/location of ground and air platforms (with FASR), optical sighting systems (CPS), and muzzle flashes (with MFD). Only laser threats directed against the vehicle are detected. Audible alert tones are sounded and threat icons are displayed on the CCDP when VIDS detects an enemy laser emission (LRF, LBR, or LD) or detects a missile launch. Voice messages are delivered when helicopters are detected or identified. Ground and air icons are displayed on the CCDP when threat radar emissions strike the VIDS-equipped vehicle or VIDS radar detects, classifies, and tracks ground or air platforms in its sensor range. VIDS can respond to any detected threat using Flares (to attract and decoy incoming IR-guided missiles), CPS (to disrupt optical tracking systems), TCS (to deflect incoming missiles or projectiles), LCMD (to divert incoming missiles), or CF (to align the main gun with the threat) in semiautomatic or automatic mode.

49. Please indicate your overall mode preference (circle one):

Semi-automatic Automatic

50. Please indicate why you prefer the mode you chose.

Additional Comments:

VIDS TACTICAL QUESTIONNAIRE

Date __________ Simulator Call Sign ______

Duty Position (circle one): PL PSG PLW PSW

Using the scale below, rate each item to reflect your observations of the scenarios during which **VIDS** was used.

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

1. _____ Maneuvering on the battlefield <u>before</u> contact
2. _____ Maneuvering on the battlefield <u>during</u> contact
3. _____ Ability to position weapon systems on the battlefield
4. _____ Target Acquisition (e.g., detection and identification)
5. _____ Target Engagement (e.g., accuracy and timeliness)
6. _____ Ability to mass fire on targets
7. _____ Maneuvering on the battlefield after contact
8. _____ Unit Performance
9. _____ Effectiveness of VIDS sensors and countermeasures:
   - a. _____ LWR+ (Enhanced Laser Warning Receiver)
   - b. _____ MWS+ (Enhanced Missile Warning Sensor)
   - c. _____ NIS (Non-Imaging System)
   - d. _____ FASR (Future Armored System Radar)
   - e. _____ TRWR (Tank Radar Warning Receiver)
   - f. _____ MCD (Missile Countermeasure Device)
   - g. _____ POMALS (Pedestal Operated Multi-Ammunition Launch System)
   - h. _____ MFD (Muzzle Flash Detector: part of TCS)
   - i. _____ CPS (Combat Protection System)
   - j. _____ LCMD (Laser Countermeasure Device)

VIDS TACTICAL QUESTIONNAIRE

1	2	3	4	5
Poor	Below Average	Average	Above Average	Excellent

k. _____ TCS (Threat Countermeasure System)

l. _____ Flares

m. _____ CF (Counterfire with main gun)

10. Please explain any "Below Average" or "Poor" ratings in Questions #1-9 regarding the use of VIDS (write the Question # and letter, if appropriate, beside comment):

_____

_____

_____

_____

_____

11. Did combat effectiveness improve with the use of VIDS? Please explain your answer.

_____

_____

_____

_____

_____

12. Did VIDS in any way negatively impact TC/gunner coordination (e.g., did the gunner have more difficulty in acquiring or engaging targets)? Please explain your answer.

_____

_____

_____

_____

VIDS TACTICAL QUESTIONNAIRE

13. What benefits/problems did you observe regarding platoon maneuver and fires?

____

____

____

____

____

14. Did VIDS allow you to react more rapidly during tactical operations? Please explain your answer.

____

____

____

____

____

15. How did your tactical strategies change, if at all, when you used VIDS?

____

____

____

____

____

16. What tactical changes might be made on the future battlefield if tanks were equipped with VIDS?

____

____

____

____

____

VIDS TACTICAL QUESTIONNAIRE

17. What configuration(s) (sensors and/or countermeasures) of VIDS were most effective? Why?

18. What other types of sensors or countermeasures do you think would be appropriate/effective? Why?

19. What guidance can you offer regarding the tactical use of sensors, countermeasures, and counterfire with VIDS?

20. In what tactical situations were each of the VIDS modes (semiautomatic or automatic) most effective? Why?

21. Was VIDS more useful in offensive or defensive situations? Explain your answer.

22. List at least three ways in which VIDS improved your tactical performance.

23. What problems do you foresee in using VIDS?

VIDS TACTICAL QUESTIONNAIRE

24. What new training requirements do you see associated with VIDS?

25. In what ways do you think the simulation environment (e.g., modeling of SAFOR) affected the outcomes of this test?

Additional Comments:

Appendix H

Evaluation Schedule

VIDS EVALUATION: CYCLE 1 (MARCH 9 - 18)

EVALUATION SCHEDULE				
CONFIGURATION	MODE	SCENARIO	TRIAL	DATE
Baseline	--	a	1.01	3/09
		b	1.02	3/09
		c	1.03	3/10
AAR / Workload Assessment				
1	Semi	b	1.04	3/10
		c	1.05	3/10
		a	1.06	3/11
AAR / Workload Assessment				
4	Auto	c	1.07	3/11
		a	1.08	3/11
		b	1.09	3/11
AAR / Workload Assessment				
2	Semi	a	1.10	3/11
		c	1.11	3/14
		b	1.12	3/14
AAR / Workload Assessment				
3	Auto	c	1.13	3/14
		b	1.14	3/14
		a	1.15	3/14
AAR / Workload Assessment				
4	Semi	b	1.16	3/15
		a	1.17	3/15
		c	1.18	3/15
AAR / Workload Assessment				
1	Auto	a	1.19	3/15
		b	1.20	3/15
		c	1.21	3/16
AAR / Workload Assessment				
3	Semi	b	1.22	3/16
		c	1.23	3/16
		a	1.24	3/16
AAR / Workload Assessment				
2	Auto	c	1.25	3/16
		a	1.26	3/17
		b	1.27	3/17
AAR / Workload Assessment				
Baseline	--	c	1.28	3/17
		b	1.29	3/17
		a	1.30	3/17
AAR / Workload Assessment				

VIDS EVALUATION: CYCLE 2 (MARCH 23 - APRIL 1)

EVALUATION SCHEDULE				
CONFIGURATION	MODE	SCENARIO	TRIAL	DATE
Baseline	--	c b a	2.01 2.02 2.03	3/23 3/23 3/24
AAR / Workload Assessment				
2	Auto	b a c	2.04 2.05 2.06	3/24 3/24 3/24
AAR / Workload Assessment				
1	Semi	a c b	2.07 2.08 2.09	3/25 3/25 3/25
AAR / Workload Assessment				
3	Auto	a b c	2.10 2.11 2.12	3/25 3/25 3/28
AAR / Workload Assessment				
4	Semi	b c a	2.13 2.14 2.15	3/28 3/28 3/28
AAR / Workload Assessment				
1	Auto	c a b	2.16 2.17 2.18	3/28 3/28 3/29
AAR / Workload Assessment				
2	Semi	c b a	2.19 2.20 2.21	3/29 3/29 3/29
AAR / Workload Assessment				
4	Auto	b a c	2.22 2.23 2.24	3/29 3/30 3/30
AAR / Workload Assessment				
3	Semi	a c b	2.25 2.26 2.27	3/30 3/30 3/30
AAR / Workload Assessment				
Baseline	--	a b c	2.28 2.29 2.30	3/30 3/31 3/31
AAR / Workload Assessment				

VIDS EVALUATION: CYCLE 3 (APRIL 6 - 15)

EVALUATION SCHEDULE				
CONFIGURATION	MODE	SCENARIO	TRIAL	DATE
Baseline	--	b c a	3.01 3.02 3.03	4/06 4/06 4/07
AAR / Workload Assessment				
3	Semi	c a b	3.04 3.05 3.06	4/07 4/07 4/07
AAR / Workload Assessment				
2	Auto	a c b	3.07 3.08 3.09	4/07 4/08 4/08
AAR / Workload Assessment				
4	Semi	a b c	3.10 3.11 3.12	4/08 4/08 4/08
AAR / Workload Assessment				
1	Auto	b a c	3.13 3.14 3.15	4/11 4/11 4/11
AAR / Workload Assessment				
2	Semi	a b c	3.16 3.17 3.18	4/12 4/12 4/12
AAR / Workload Assessment				
3	Auto	a c b	3.19 3.20 3.21	4/12 4/12 4/13
AAR / Workload Assessment				
1	Semi	c b a	3.22 3.23 3.24	4/13 4/13 4/13
AAR / Workload Assessment				
4	Auto	b c a	3.25 3.26 3.27	4/14 4/14 4/14
AAR / Workload Assessment				
Baseline	--	c a b	3.28 3.29 3.30	4/14 4/14 4/14
AAR / Workload Assessment				

VIDS EVALUATION: CYCLE 4 (APRIL 20 - 29)

EVALUATION SCHEDULE				
CONFIGURATION	MODE	SCENARIO	TRIAL	DATE
Baseline	--	a	4.01	4/20
		c	4.02	4/20
		b	4.03	4/20
AAR / Workload Assessment				
4	Auto	c	4.04	4/21
		b	4.05	4/21
		a	4.06	4/21
AAR / Workload Assessment				
3	Semi	b	4.07	4/21
		a	4.08	4/21
		c	4.09	4/21
AAR / Workload Assessment				
1	Auto	a	4.10	4/22
		b	4.11	4/22
		c	4.12	4/22
AAR / Workload Assessment				
2	Semi	b	4.13	4/22
		c	4.14	4/22
		a	4.15	4/25
AAR / Workload Assessment				
3	Auto	c	4.16	4/25
		a	4.17	4/25
		b	4.18	4/25
AAR / Workload Assessment				
4	Semi	a	4.19	4/25
		c	4.20	4/25
		b	4.21	4/25
AAR / Workload Assessment				
2	Auto	c	4.22	4/26
		b	4.23	4/26
		a	4.24	4/26
AAR / Workload Assessment				
1	Semi	b	4.25	4/26
		c	4.26	4/26
		a	4.27	4/26
AAR / Workload Assessment				
Baseline	--	b	4.28	4/26
		c	4.29	4/28
		a	4.30	4/28
AAR / Workload Assessment				

Appendix I

Contingency Rules

VIDS PHASE II EVALUATION

CONTINGENCY RULES FOR PERSONNEL, TECHNICAL AND EXERCISE PROBLEMS

These contingency rules address general and specific problem areas that may be encountered during the conduct of the VIDS Phase II Evaluation. These rules are guidelines that should be used as appropriate. Decision makers will be required to exercise professional judgement in all applications of these rules.

Contents

A. General Rules

1. **Decision Authority**: The Evaluation Director assigned to the research effort retains overall decision authority for any and all matters that may impact on the conduct of the test or the data collection effort.

2. **Basic Approach**:

a. The option with the least disruptive overall impact will normally be the preferred course of action. The goal is to identify solutions which minimize impacts on:

(1) The data collected or the measures involved (e.g., lost or contaminated data).

(2) Command and control dynamics (e.g., interaction between the Battle Master, Company Commander, Control Staff and the platoon).

(3) Scenario execution, including SAFOR (e.g., firepower, maneuver, mission accomplishment).

b. Whenever problems are encountered that may impact on

test conduct, an estimate of the time necessary to correct the situation will be made. Delays will normally be appropriate for short-term problems and may be necessary for long-term problems. See "B. Rules for Missing Participants" and "E. Rules for Technical Problems" for a comprehensive set of decision guidelines.

(1) Short-term problems are those which can likely be corrected within the time frame of a training period, training exercise, or evaluation scenario. That is, a problem that can be corrected quickly enough to allow the current and subsequent exercises to be completed on the day scheduled. Example: replacing an IDC board in a simulator with a board that is in stock on-site.

(2) Long-term problems are those likely to outlast the current event (as described above). That is, a problem that cannot be "worked around" or corrected quickly which could result in exercises being shifted to later in the day or the next day. Example: a faulty IDC board for which no replacement is available on-site.

(3) The weekly schedule will be followed for all scheduled training and test events until delays occur. When delays occur, the primary goal is to accomplish all training or evaluation exercises on the day for which it is scheduled. If an event is not accomplished on the day scheduled, the Evaluation Director will publish a revised exercise schedule at the earliest opportunity. Events will be rescheduled so as to accomplish required data collection activities and standardize the collective training sequence across iterations. See "F. Rules for Schedule Adjustments when Delays Occur."

3. **Standardization:**

a. The events lists detail the actions which exercise control personnel must ensure are accomplished during each scenario training and evaluation . Control staff will ensure that all events are executed, and that ad lib communications with participants are consistent with the events, based on the progress of the scenario.

b. All control staff will avoid conversation that provides the current evaluation group with any information about the performance of prior evaluation groups. This includes characterizing the current group's performance in terms of implied norms (e.g., "average" or "better than average"). Such information is confidential and may contaminate evaluation results.

c. Staff personnel will not volunteer information pertinent to the evaluation scenarios either prior to or during the evaluation. Staff personnel may answer questions regarding tactical/technical information that should not be withheld (e.g., the Company Commander giving a platoon leader information or direction to a location or a Research Assistant (RA) confirming non-operational status of the VIDS or simulator.

d. Staff personnel will ensure that participants do not gain inadvertent access to evaluation information or premature access to scenario events. At no time will participants be allowed in the Exercise Control Area (ECA) without permission of the Evaluation Director, Battle Master, or Company Commander. The platoon leader will be permitted access in the ECA only when it is deemed necessary to reorient the platoon after major problems are encountered (e.g., a major system crash resulting in the platoon being reconstituted in a new location of the database or the platoon loses complete orientation to the terrain and becomes separated to the extent of impacting on the next scheduled scenario event). No crew member will enter a simulator prior to the specified in-sim time for unit exercises. Staff-only paper materials will be safeguarded from participant access in the ECA as well as classrooms and RA room.

4. **Visitors:**

a. The Evaluation Director is the on-site POC for any and all visitors during VIDS evaluation. In general, visitors will not be allowed inside the ECA or allowed in the vicinity of the VIDS simulators. Visits will be coordinated through MWBL, ARI, DCD, MWTB senior officer and/or the MWTB site manager. The MWTB receptionist will be kept aware of scheduled visits, and will refer unannounced visitors to the Evaluation Director, Battle Master, MWTB senior officer, and/or the site manager.

b. Visitors' conversations with staff will normally be limited to breaks. At no time will visitors be allowed to question staff or participants during conduct of training or evaluation events. Official visitors will be granted limited access to controlled areas (e.g., ECA) based on the visitors' need-to-know, and the nature of ongoing training and evaluation activities.

c. Neither research staff nor participants will receive unofficial visitors (e.g., family members, friends, etc.) in the research facility during the conduct of training or evaluation activities.

5. **Administrative Actions:**

a. The Evaluation Director and/or Battle Master will ensure that the participant chain of command, exercise control personnel, simulator RAs, and MWTB technicians are informed of all changes to the training and evaluation schedule.

b. All adjustments to the training and evaluation program, to include personnel, equipment, and schedule will be documented on affected data collection logs. The Evaluation Director will be notified of any changes prior to starting any training and evaluation activities to ensure proper coordination of noted changes.

B. Rules for Missing Participants

1. **General:** The Evaluation Director will verify that all participants are aware of attendance requirements for the training and evaluation cycle during the initial introductory briefing. Soldiers with appointments or other anticipated absences will either reschedule the appointment or be replaced by the unit prior to the start of their training.

2. **Battle Roster:**

a. Vehicle commander, Gunner, and Driver assignments will become permanent as soon as the Battle Roster is completed by the Battle Master (i.e., at the end of the introductory briefing). The participating unit will be notified if substitutions are needed and will need to find suitable substitutes before seat specific training occurs that morning.

b. Vehicle commander absences: A vehicle commander's absence for training or evaluation events may require delays in those activities until the vehicle commander arrives or require running platoons in degraded mode (i.e., three vehicle platoon).

(1) Training events: In the event the vehicle commander will be absent during critical training events, the vehicle commander will need to be replaced with a suitable substitute for the rest of the cycle. (This may incur additional training time and possibly after hours individual training.) Collective training events will be delayed until the new vehicle commander is trained.

(2) Evaluation events: A vehicle commander's absence during evaluation events may necessitate the delay of that event until the vehicle commander arrives. If the delay is temporary (i.e., less than an hour), the evaluation event will be delayed until the vehicle commander's arrival. If the delay is

anticipated to be longer than one hour, the event will start as a three vehicle platoon and be flagged accordingly in the datalogger and manual logs.

(3) Platoon Leader absence: The platoon leader's absence is a special case of vehicle commander's absence. The platoon leader is critical to the evaluation and requires delay of evaluation events until his arrival. In the case that the evaluation is delayed up to a day in length, the Evaluation Director(s) and Battle Master will determine if after hours or weekend makeup will be needed based on anticipated impact on the scheduled events.

c. Gunner and Driver absences: If a Gunner and Driver should be absent for critical collective training events, the Evaluation Director and Battle Master should be notified prior to the start of the training. The unit will be notified for a suitable replacement which will become the permanent replacement for that crew member. Individual training will be conducted for that individual as soon as possible so collective training can proceed. If gunner or drivers are absent for an evaluation event, the evaluation event will be delayed (up to one hour) until the crew member arrives or until the unit can send a suitable replacement. Any replacements will be noted in the appropriate logs.

3. **Term of Absence**:

a. If it appears a participant may miss a significant portion of a collective training events, the training will be halted until a suitable permanent replacement is assigned. All participants must complete all individual and collective training. Significant portions of collective training include (but are not limited to): the entire crew and platoon training period. The Evaluation Director will consult with other research staff (RAs) to determine whether a short-term absence during a portion of any period constitutes a significant loss of scheduled training, and therefore becomes grounds for dismissal of the participant.

b. Temporary (short-term) absences justify delayed start times for training events. Once a training or evaluation event begins, the participant group will remain constant for the remainder of the event unless an emergency arises. Permanent vehicle commander absences will affect the force ratio of the events. It is therefore preferable to delay the start of an event if the absent vehicle commander is expected to return soon. If a participant is called away temporarily after a scenario starts, he will resume his position at an appropriate break point when he returns, unless the loss of training meets the preceding

criteria and results in his dismissal.

c. The loss of up to one crew (as the result of a vehicle commander absence) can be tolerated for a test cycle. The loss of a second crew represents an unacceptable level of lost data for that cycle and could mean losing an entire cycle of data from the evaluation.

C. Rules for Missing Research Staff

The exercise staffing plan (Table I) identifies primary and back-up personnel for all key positions. The Exercise Director will manage personnel issues not covered in the established contingency plan, as required.

2. Training assignments are managed by the floor monitor with the concurrence of the Exercise Director.

TABLE I. EXERCISE STAFFING PLAN

EVALUATION POSITION	PRIMARY STAFF	BACK-UP
Evaluation Director	Elliott, G.	Jarboe, J.
Battle Master/Elec. Cpbd. Op.	Dreby, CPT	Iddins, CPT[a]
Company Commander	Iddins, CPT	______
Data Manager	Jarboe, J.	Elliott, G.
Team Manager	Lozicki, R.	Pitney, S.
Asst. Battle Master/Stealth Op.	Pitney, S.	Lozicki, R.
SAFOR Operator	Voss, T.	Pitney, S.
Research Analyst	Wong, D.	______
Research Assistant/Trainer	Fergus, K. Johnson, D. Schultz, D. West, C.	Wong, D.[b]

[a] In the absence of the primary Battle Master/Electronic Clipboard Operator, CPT Iddins becomes Battle Master/Company Commander and J. Jarboe becomes Electronic Clipboard Operator.

[b] D. Wong is temporary replacement only; contractor provides permanent Research Assistant.

D. Rules for Participant/Staff Interaction

1. The purpose of VIDS participant training is to prepare soldiers to operate the simulators during the evaluation exercises. The performance of some tasks during evaluation scenarios and events is critical to the success of the evaluation, as a whole. If a participant is experiencing difficulty accomplishing a discrete VIDS CCDP task that is critical to the exercise (e.g., deleting "ghost" icons from previous events using the DSPLY fixed function key), unobtrusive prompts or hints should be used to lead the participant through the task, at the discretion of the Evaluation Director.

2. During training and evaluation events, control staff personnel in the ECA will remain in character during all tactical communications with participants. This includes most communications between the Company Commander and the platoon leader in order to maintain the focus on the tactical exercise. Control staff will step out of character only for administrative communications.

3. Participant requests for information from the ECA will be handled as follows:

a. Information that represents feedback, synthesis of previously reported information, or the status of an ongoing action will be provided immediately. For example, if the Platoon Leader asks the status of a fire mission, the Company Commander may respond "guns are repositioning."

b. If the information is or may be tactically relevant to the current situation it will be provided if the Battle Master or Company Commander decides it is necessary to preserve the validity of the scenario event. For example, if the platoon appears disoriented or requests location information, the Company Commander may direct the platoon to make a deviation in their current route in order for the platoon to reach a certain location for a meeting engagement. Other information without immediate tactical relevance may be transmitted for the sake of realism.

c. A set of procedural rules for SAF operator guidelines is published separately as the "SAF Procedural Guidelines." The procedural guidelines are rules for the control of SAF vehicles, for starts and conclusions of scenario events, and for emergency events.

E. Rules for Technical Problems

1. **Simulator or Software Breakdowns:**

a. Short-term:

(1) Minor problems (e.g., non-critical CCDP lock-ups): Restart or reboot the PC depending on the severity of the lock-up. Suspend the training/exercise if severe lock-ups or other simulator malfunctions occur or happen simultaneously.

(2) Major problems (e.g., SAFOR or simulator crash): delay start of training/exercise or suspend training/exercise for repairs.

b. Long-term: The loss of up to one simulator may be accommodated for a training scenario or evaluation scenario. The loss of a second simulator would result in unacceptable training or data loss. In that event, the Evaluation Director will coordinate with the Battle Master and control staff personnel to determine what follow-up action is feasible. If the simulator can be returned to operation prior to the end of the evaluation cycle, it may be used if the crew is considered available, as described in subparagraph (3) below. The following actions will be taken to adjust for the loss of simulators:

(1) During individual training, double up on available trainers.

(2) During collective training and evaluation events, reallocate simulators as follows: For training and evaluation scenarios maintain the Platoon Leader, Platoon Sergeant, and Platoon Sergeant Wingman.

(3) If a crew loses significant training because of a simulator breakdown, then the crew will be retrained if time permits. If not enough time is available, the crew will be dismissed and the evaluation cycle will continue with the reduced number of crews and operating simulators. If the simulator is subsequently repaired, it will serve as a back-up for the remainder of the evaluation cycle.

2. **VIDS/CCDP:**

a. No training event or evaluation scenario (for VIDS configured vehicles) should begin if the VIDS system (including the CCDP) is not functioning.

b. If the VIDS system malfunction occurs during the VIDS training events (except for STXs), the training will be halted

until the system is back on-line. If it appears to be a long-term delay, the vehicle commander will double up with another working simulator (refer to Paragraph E.1.b.(1)).

c. If the VIDS system malfunction occurs during scenario execution, refer to procedures in Paragraph E.1.b.

d. CCDP malfunction: If the touch screen monitor malfunctions during the training events or scenario execution, halt the event and allow the technicians time (10-15 minutes) to determine and fix the CCDP. If the touch screen monitor is in need of repair, technicians will remove the touch screen monitor and replace it with a back-up monitor or, in the worst case, a mouse interface. The event can be restarted with the full platoon. If the simulator with mouse interface is used, it will be noted in appropriate logs.

3. **Radios:**

a. Simulators: Short-term malfunctions will be repaired as soon as possible, commensurate with rules for VIDS and simulator breakdowns (Paragraph E.1.a). Long-term malfunctions will be handled similarly to procedures listed in Paragraph E.1.b.

b. ECA. For long-term malfunctions affecting training/evaluation scenario(s). Suspend or delay training and evaluation events until repaired or replaced.

4. **SAFOR:**

a. No training scenario or evaluation scenario will begin if sufficient SAFOR equipment is non-functional.

b. If a SAFOR malfunction occurs during a scenario, the normal course of action will be to freeze the scenario and save the exercise on the workstation immediately. As soon as the malfunction is resolved, the scenario will resume as soon as the exercise can be restored on the workstation.

F. Rules for Schedule Adjustments When Delays Occur

1. No more than six evaluation scenarios will be conducted in a single day (normal load will be five per day). The pre-mission preparations will occur prior to the start of each scenario.

2. Collective training and evaluation exercises will be terminated:

a. Upon completion of the scenario;

b. At the end of the training day; or

c. At a logical point when the maximum time allotted for the exercise is fulfilled, at the discretion of the Evaluation Director or Battle Master. Time allocations for training and exercise events are shown in Table II. "Execution time," as used in Table II, refers to the actual run time of listed scenario events from "T-hour" to scenario completion, less breaks and maintenance down-time.

TABLE II. MAXIMUM TIMES FOR TRAINING AND EVALUATION EVENTS

EVENT	EXECUTION TIME	MARGIN
DEF STX	2:00	± 15 min.
OFF STX	3:00	± 15 min.
Evaluation Scenario	1:10	± 10 min.
Delay Evaluation	1:30	± 10 min.
BCIS Excursion Scenario	1:00	± 10 min.
Freeplay Excursion Scenario	1:10	± 10 min.

3. When problems occur during the conduct of hands-on training or evaluation, the Evaluation Director and Battle Master will determine whether participants will remain in place (in simulators) or be allowed to go on break. Generally, participants will not be left in place for greater than 10 to 15 minutes. When maintenance delays occur, participants will be asked <u>not</u> to discuss the ongoing scenario with the exercise staff or each other.

4. Between-scenario breaks may coincide with a lunch break.

5. Exercises may continue after 1700 hrs if coordination with the site manager has verified that site support staff are available. No scenario will be continued overnight.

6. The AAR/debriefing may be delayed to the next day, if necessary.

G. Rules for Deviations from Planned Events

1. **Allowable Deviations:**

a. Generally, tactical situations which progress logically

through events will be allowed to play themselves through to a natural conclusion. The Battle Master and Company Commander will avoid limiting the tactical decisions of the Platoon Leader unless his decisions will adversely impact on the sequence of scheduled events. The SAFOR operator and Assistant Battle Master will execute the orders given them from Battle Master and Company Commander. The SAFOR operator and Assistant Battle Master may advise the Battle Master or Company Commander of available options if the situation warrants.

b. Under no circumstances will SAFOR engagement parameters be modified (without express guidance form the Battle Master), or the artillery used to kill off OPFOR units during the course of an event or scenario.

2. **Misoriented Participants**:

a. The Company Commander will give precise position data to participants over the radio in the case the platoon appears misoriented. This will be done in circumstances in which the platoon will miss the next scheduled scenario event.

b. Under the conditions of this evaluation, the vehicle commanders will be instructed to actively navigate their own vehicles. If a manned simulator is separated from the other platoon elements (due to simulator problems or disorientation), the Battle Master and/or Company Commander will determine whether to let the Platoon Leader redirect the lost crew or provide direction to help the crew reorient itself. Generally, if the platoon leader continues to maintain effective command and control of his elements, he will be left alone.

b. If the lost crew is in line of sight of any platoon element, tactically appropriate actions, consistent with fratricide prevention procedures, will be taken to identify the vehicle and direct it to the platoon. Example: the lost vehicle reports an unidentified vehicle to his front (or flank). The Platoon Leader will be informed he has a lost vehicle (if he does not know) and the Platoon Leader will direct the vehicle to the appropriate location.

c. If the crew asks for help or is out of LOS contact, help will be provided by the Battle Master or Company Commander. The Battle Master or Company Commander will direct the vehicle to the location of his platoon by giving bearing and range information or actually direct his immediate movement and speed to expedite his arrival.

3. **Misunderstood Orders or FRAGOs**: Every effort (save the extension of preparatory time) will be made prior to execution to

ensure that all participants understand the mission. The Battle Master and the Company Commander will remain alert to orders from the Platoon Leader that do not correspond with the established plan or radio orders (e.g., imply misunderstanding). Generally, these will be handled as allowable deviations, unless the change might result in the loss of significant data (e.g., takes the unit out of position for a the next engagement). If the Platoon Leaders give such orders, the Battle Master and/or Company Commander will determine whether to intervene. Possible interventions include:

a. Direct that SAFOR march rates be modified so that the OPFOR intercepts the unit at a suitable location, or such that the OPFOR's arrival is delayed until the unit is back in position.

b. Assume a tactical role to verify the platoon's position and intentions, and influence the Platoon to revert to a more suitable scheme of maneuver (e.g., get the unit back where it belongs).

c. Take a direct role and order the Platoon Leader to a specific location, direction, or position.

4. **Inappropriate Initiative:** The Battle Master and/or Company Commander will caution participants against unrealistically aggressive behavior that takes advantage of the kill suppress feature (e.g., the Platoon Leader counterattacks or performs high-risk reconnaissance). The kill suppress feature will not be addressed or acknowledged by the Battle Master and/or Company Commander directly in any "open forum" (e.g: scenario debriefing). At the conclusion of the evaluation in the AAR, this topic will be addressed. At that time, the rationale for kill suppress and its implications will be discussed. Participants will be asked to assume the responsibility for appropriate behavior. Subsequent instances will be addressed either as a group or one-on-one between the Battle Master or Company Commander and the individual participant.

Appendix J

Structured Group Debrief Outline

VIDS PHASE II
STRUCTURED GROUP DEBRIEF

1. How did the different VIDS configuration affect your lethality and survivability against the following engagements?

   a. Air Attack

      (1) One HIND w/ AT-6:

      (2) Three HINDs w/ AT-6:

      (3) Two HINDs w/ AT-9:

   b. Armor Platoons

      (1) Three BDRMs w/ AT-2:

      (2) Three T-80s w/ main gun:

      (3) Enemy tank company w/ AT-11 and main gun:

      (4) Enemy long range ambush by 3 T-80s w/ AT-11:

      (5) Enemy short range ambush by 1 BDRM w/ AT-4:

(6) Hasty attack against mechanized platoon by 2 BDRMs w /AT-4:

2. Did the evaluation scenarios provide good opportunities to test VIDS' capabilities? Were they realistic?

3. Did the OPFOR operate realistically in the scenarios?

4. Did you find it difficult to decide what to do when VIDS alerted you to a threat, especially in semi-automatic mode?

5. Did you have sufficient time to react to threat alerts?

6. How would you compare semi-automatic with automatic mode?

7. What difficulties did you encounter because you were locked into a particular mode for an entire scenario?

8. What VIDS features did you like (i.e., visual alerts, sound alerts, voice messages, CMs, and CF)? Which features did you dislike?

9. How would you change the VIDS display and controls?

10. What are the advantages of a VIDS system? The disadvantages?

11. Did VIDS help give you a better picture of the battlefield?

12. If VIDS were fielded, how would it change armor tactics, techniques, and procedures?

Battlefield Operating System (BOS):

a. Fire Support:

b. Intelligence:

c. Maneuver:

d. Mobility, Countermobility, Survivability:

e. Communication:

f. Command and Control:

g. Air Defense:

13. When you finished training, were you satisfied with your level of proficiency and understanding of VIDS?

14. Which part of the training would you like to spend more time on? How could training be improved?

15. What serious limitations do you see in the way we are conducting our evaluation?

16. Any other comments?

Appendix K

Performance Measure Definitions

SURVIVABILITY

Main Gun

Number of main gun hits taken:
Number of main gun hits taken from OPFOR per engagement event per scenario, collected for each manned vehicle and summed across the four manned vehicles to produce the platoon value.

Number of catastrophic kills taken:
Number of catastrophic kills taken from OPFOR main gun during each engagement event per scenario, collected for the four individual manned vehicles, then summed to produce the platoon value.

Number of main gun rounds fired at manned vehicles:
Number of OPFOR main gun rounds fired at manned vehicles during an engagement event per scenario, collected for each manned vehicle, summed across the four manned vehicles to produce the platoon value.

Range of main gun hits taken:
Average range in meters of main gun hits by OPFOR on manned vehicles. The platoon value was computed by multiplying the vehicle average range by the number of main gun hits during each engagement event per scenario, summing this across the four manned vehicles, then dividing by the sum of the OPFOR main gun hits on the four manned vehicles.

Range of main gun kills taken:
Average range in meters of main gun kills by OPFOR on manned vehicles. The platoon value was computed by multiplying the vehicle average range by the number of main gun kills during each engagement event per scenario, summing this across the four manned vehicles, then dividing by the sum of the OPFOR main gun kills on the four manned vehicles.

Missile

Number of missile hits taken:
Hits taken from OPFOR missiles. Recorded for each manned vehicle per engagement event per scenario, summed across the four manned vehicles to produce the platoon value.

Number of enemy missiles fired:
The sum of missiles fired at known targets and at unknown targets during each engagement event per scenario. When missiles were grounded by countermeasures, they often struck ground so far from the intended target that the intended target could not be identified.

Range of missile hits taken:
Average range in meters of missile hits by OPFOR on manned vehicles per engagement event per scenario. The platoon value

was computed by multiplying the vehicle average range by the number of missile hits, summing this across the four manned vehicles, then dividing by the sum of the OPFOR missile hits on the four manned vehicles.

__All Munitions__

Time from opening to first hit taken:
Time from first round fired to first hit taken (in seconds) in each engagement event per scenario. The beginning time was the earliest of: first round fired by manned vehicle, first hit scored by manned vehicle, first round fired by OPFOR at known target, and first round fired by OPFOR at unknown target. Ending time was time of first hit scored by OPFOR on a manned vehicle. The variable value was the difference between the beginning and ending times.

__Fratricide__

Lases to friendly vehicles:
Total lases of manned vehicles to other manned vehicles during each engagement event per scenario, recorded for each vehicle and summed to produce the platoon value.

Firings at friendly vehicles:
Total firings of manned vehicles at other manned vehicles during each engagement event per scenario, recorded for each vehicle and summed to produce the platoon value.

Hits on friendly vehicles:
Total hits on manned vehicles by other manned vehicles in each engagement event per scenario, recorded for each vehicle and summed to produce the platoon value.

Kills on friendly vehicles:
Total catastrophic kills of manned vehicles committed by other manned vehicles per engagement event per scenario, recorded for each vehicle and summed to produce the platoon value.

CPS Engagements of friendlies:
Total CPS engagements of friendlies, recorded for each manned vehicle and summed across the four manned vehicles to produce the platoon value. Value computed for each engagement event per scenario.

CPS firepower kills of friendlies:
Total CPS firepower kills of friendlies, recorded for each manned vehicle and summed across the four manned vehicles to produce the platoon value. Value computed for each engagement event per scenario.

LETHALITY

Detection

First contact time:
Time (in seconds)from beginning of engagement event per scenario until first contact is reported over radio.

Contact to first round time:
Time (in seconds) from first reported contact per engagement event per scenario until first round is fired by a friendly vehicle.

Range of first lase:
The range in meters of the first lasing was recorded for each manned vehicle per engagement event per scenario. The maximum of these values was taken as the platoon value.

Acquisition and Engagement

Hits per round ratio:
Hits per round by the manned vehicles. Number of hits and number of rounds fired was recorded for each manned vehicle per engagement per scenario. The sum of hits across the four manned vehicles was divided by the sum of rounds fired across the four manned vehicles to produce the platoon value.

Kill time:
Time to kill all OPFOR. The time interval from the first kill on OPFOR by any manned vehicle to the last kill on OPFOR by any manned vehicle during each engagement event per scenario.

Number of kills:
Total catastrophic kills on OPFOR by manned vehicles per engagement event per scenario, recorded for each manned vehicle and summed to produce the platoon value.

Kill range:
Average catastrophic kill range on OPFOR per engagement event per scenario. Average kill range was recorded for each manned vehicle. Average kill range was multiplied by number of catastrophic kills, summed across the four manned vehicles, then divided by the sum of catastrophic kills.

Number of kills before first platoon hit:
Number of OPFOR killed before first hit taken by a manned vehicle during each engagement event per scenario, recorded for each vehicle and summed to produce the platoon value.

Number of kills before first platoon kill:
Number of OPFOR killed before first kill taken by a manned vehicle during each engagement event per scenario, recorded for each vehicle and summed to produce the platoon value.

Appendix L

Summary Data Tables of Results

Contents of Appendix L:

Table L-1

Summary of Univariate F-Tests on Survivability: Main Gun Performance Measures

		Fires		Hits		Hits	
Effect	df	F	(p)	F	(p)	F	(p)
Main Effect							
Block (B)	1,3	4.45	(.125)	3.07	(.178)	4.65	(.120)
Config (C)	3,9	8.04	(.006)*	6.88	(.011)*	8.88	(.005)*
Scene (S)	2,6	1.88	(.232)	1.64	(.269)	1.16	(.375)
Event (E)	1,3	5.28	(.105)	2.03	(.249)	3.24	(.170)
Two-way Interactions							
B x C	3,9	7.38	(.008)*	5.34	(.022)	5.76	(.018)
B x S	2,6	.06	(.938)	.16	(.856)	.46	(.653)
B x E	1,3	9.43	(.055)	8.08	(.065)	12.78	(.037)
C x S	6,18	1.16	(.368)	1.43	(.259)	1.24	(.333)
C x E	3,9	4.46	(.035)	3.71	(.055)	4.46	(.035)
S x E	2,6	.98	(.426)	.82	(.484)	.31	(.744)
Three-way Interactions							
B x C x S	6,18	1.21	(.346)	1.81	(.360)	.83	(.560)
B x C x E	3,9	4.74	(.030)	3.24	(.075)	5.10	(.025)
B x S x E	2,6	.20	(.825)	.10	(.905)	.61	(.572)
C x S x E	6,18	.94	(.490)	.86	(.541)	.64	(.700)
Mode Effects							
Mode (M)	1,3	.33	(.604)	.14	(.731)	.25	(.655)
C x M	2,6	1.96	(.221)	1.86	(.235)	1.36	(.327)
C x M x E	2,6	1.15	(.379)	.95	(.439)	.92	(.448)

Note. * $p < .017$ to maintain family-wise error rate for this group of dependent variables at .10 level of significance.

Table L-2

Means and Standard Deviations (in parentheses) for Configuration on Survivability: Main Gun Performance Measures

	Configuration			
Measure	B	1	3	4
Fires	21.42a (7.76)	15.33 (12.44)	3.10b (1.72)	1.77b (.39)
Hits	13.85a (7.06)	8.73 (7.29)	2.60b (1.69)	1.54b (.25)
Hits	7.94a (4.43)	4.15 (3.24)	.71b (.28)	.13c (.05)

Note. B = Baseline. $n = 4$. Means in the same row with different letters differ, $p < .033$, one-tailed Bonferroni t test.

Table L-3

Summary of Bonferroni t tests for Configuration on Survivability: Main Gun Performance Measures

Comparison	df	Fires t	Fires (p)	Hits t	Hits (p)	Hits t	Hits (p)
Base vs 1	3	.99	(.200)	1.56	(.109)	2.23	(.056)
Base vs 3	3	4.44	(.011)*	3.18	(.025)*	3.28	(.023)*
Base vs 4	3	5.19	(.007)*	3.58	(.019)*	3.52	(.020)*
1 vs 3	3	2.22	(.057)	2.09	(.064)	2.28	(.054)
1 vs 4	3	2.25	(.055)	2.00	(.070)	2.50	(.044)
3 vs 4	3	1.84	(.082)	1.25	(.150)	4.47	(.011)*

Note. * $p < .033$, one-tailed, to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-4

Means and Standard Deviations (in parentheses) for Block by Configuration Interaction on Survivability: Main Gun Fires

Block	Configuration B	1	3	4
1	39.38a (16.70)	13.88b (5.03)	2.17c (1.96)	2.21c (.21)
2	3.46 (2.08)	16.79 (22.50)	4.04 (3.98)	1.33 (.79)

Note. B = Baseline. $n = 4$. Means in the same row with different letters differ, $p < .017$, one-tailed Bonferroni t test.

Table L-5

Summary of Bonferroni t tests for Block by Configuration Interaction on Survivability: Main Gun Fires

Comparison	df	Block 1 t	Block 1 (p)	Block 2 t	Block 2 (p)
Configuration					
Base vs 1	3	4.23	(.012)*	-1.17	(.836)
Base vs 3	3	4.12	(.013)*	-.22	(.578)
Base vs 4	3	4.47	(.011)*	1.79	(.086)
1 vs 3	3	3.77	(.017)*	1.34	(.137)
1 vs 4	3	4.65	(.010)*	1.42	(.125)
3 vs 4	3	-.04	(.511)	1.60	(.104)

Note. * $p < .017$, one-tailed, to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-6

Means and Standard Deviations (in parentheses) for Main Effects on Survivability: Main Gun Range Measures

	Block	
Measure	1	2
Hits	1081.85 (120.56)	885.13 (159.18)
# trials	75	54
Hits	1015.32 (68.39)	852.48 (199.11)
# trials	55	38

	Configuration			
Measure	B	1	3	4
Hits	1053.51 (47.15)	1166.47 (137.02)	707.03 (109.75)	969.58 (165.45)
# trials	38	38	24	29
Hits	1061.55 (62.71)	1036.50 (182.59)	635.29 (140.04)	610.39 (386.27)
# trials	37	33	17	6

	Scenario		
Measure	A	B	C
Hits	893.09 (166.62)	1301.48 (114.76)	763.95 (115.91)
# trials	38	48	43
Hits	837.48 (270.05)	1120.61 (290.19)	820.96 (41.94)
# trials	29	31	33

	Event	
Measure	B	E
Hits	559.41 (62.93)	1938.66 (95.75)
# trials	87	42
Hits	476.89 (58.32)	1891.06 (123.56)
# trials	62	31

(Table Continues)

Measure	Mode Auto	Semi
Hits	1060.75 (91.54)	897.51 (144.60)
# trials	45	46
Hits	903.22 (160.19)	846.68 (115.63)
# trials	22	34

Note. B = Baseline (in configuration). n = 4. N = 192 for total number of trials except for Mode in which N = 144. Thirty-three percent and 52% missing data for hits and kills, respectively, except for Mode in which missing data was 37% and 61%, respectively.

Table L-7

Summary of Univariate F-Tests on Survivability: Missile Performance Measures

Effect	df	Fires F (p)	Hits F (p)
Main Effect			
Block (B)	1,3	2.88 (.188)	2.13 (.241)
Config (C)	3,9	185.80 (.000)*	123.81 (.000)*
Scene (S)	2,6	9.77 (.013)*	3.78 (.087)
Event (E)	6,18	71.33 (.000)*	18.78 (.000)*
Two-way Interactions			
B x C	3,9	1.39 (.307)	2.25 (.151)
B x S	2,6	.66 (.552)	.46 (.660)
B x E	1,3	.32 (.919)	1.14 (.382)
C x S	6,18	1.64 (.193)	2.51 (.061)
C x E	18,54	10.72 (.000)*	9.77 (.000)*
S x E	12,36	5.28 (.000)*	3.45 (.002)*
Three-way Interactions			
B x C x S	6,18	.60 (.728)	1.06 (.424)
B x C x E	18,54	.62 (.865)	.71 (.786)
B x S x E	12,36	1.18 (.332)	1.31 (.258)
C x S x E		Not able to test	
Mode Effects			
Mode (M)	1,3	.25 (.655)	11.36 (.043)
C x M	2,6	.65 (.327)	3.82 (.235)
C x M x E	12,36	.67 (.771)	1.08 (.408)

Note. * p < .025 to maintain family-wise error rate for this group of dependent variables at .10 level of significance.

Table L-8

Means and Standard Deviations (in parentheses) for Configuration on Survivability: Missile Performance Measures

	Configuration			
Measure	B	1	3	4
Fires	9.95a (.56)	8.35a (1.09)	2.11b (.17)	1.45c (.18)
Hits	7.20a (.79)	3.17b (1.00)	.25c (.07)	.11d (.12)

Note. B = Baseline. $n = 4$. Means in the same row with different letters differ, $p < .033$, one-tailed Bonferroni t test.

Table L-9

Summary of Bonferroni t tests for Configuration on Survivability: Missile Performance Measures

		Fires		Hits	
Comparison	df	t	(p)	t	(p)
Configuration					
Base vs 1	3	2.63	(.039)	10.66	(.001)*
Base vs 3	3	29.21	(.000)*	17.07	(.000)*
Base vs 4	3	26.38	(.000)*	16.90	(.000)*
1 vs 3	3	10.58	(.001)*	5.52	(.006)*
1 vs 4	3	10.89	(.001)*	5.53	(.006)*
3 vs 4	3	8.36	(.002)*	5.51	(.006)*

Note. * $p < .033$, one-tailed, to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-10

Means and Standard Deviations (in parentheses) for Scenario on Survivability: Missile Fires

	Scenario		
Measure	A	B	C
Fires	5.54a (.48)	4.64b (.56)	5.96 (.34)

Note. $n = 4$. Means in the same row with different letters differ, $p < .033$, Bonferroni t test.

Table L-11

Summary of Bonferroni t tests for Scenario on Survivability: Missile Fires

		Fires
Comparison	df	t (p)
Scenario		
A vs B	3	5.06 (.015)*
A vs C	3	-1.48 (.234)*
B vs C	3	-3.39 (.043)*

Note. * $p < .033$ to maintain overall error rate the set of comparisons at .10 level of significance.

Table L-12

Means and Standard Deviations (in parentheses) for Event on Survivability: Missile Performance Measures

	Event						
Measure	A	C	D	E	F	I	J
Fires	3.10 (.48)	9.24 (.97)	3.05 (.22)	6.97 (1.09)	8.31 (.98)	5.81 (.57)	1.21 (.23)
Hits	1.54 (.32)	4.97 (.10)	1.48 (.02)	3.47 (1.82)	3.85 (.68)	2.98 (.45)	.54 (.11)

Note. $n = 4$. See Table L-13 for significant differences between each pair of events.

Table L-13

Summary of Bonferroni t tests for Event on Survivability: Missile Performance Measures

Comparison	df	Fires t	Fires (p)	Hits t	Hits (p)
Event					
A vs C	3	-1.71	(.186)	-24.67	(.000)*
A vs D	3	.19	(.865)	.40	(.714)
A vs E	3	-9.09	(.003)*	-2.05	(.133)
A vs F	3	-13.73	(.001)*	-5.04	(.015)
A vs I	3	-8.81	(.003)*	-9.19	(.003)*
A vs J	3	5.70	(.011)	4.95	(.016)
C vs D	3	1.70	(.188)	75.10	(.000)*
C vs E	3	-.10	(.924)	1.71	(.186)
C vs F	3	-.79	(.485)	3.41	(.042)
C vs I	3	.40	(.715)	11.19	(.002)*
C vs J	3	2.53	(.085)	46.75	(.000)*
D vs E	3	-7.69	(.005)*	-2.21	(.114)
D vs F	3	-11.67	(.001)*	-6.99	(.006)
D vs I	3	-11.28	(.001)*	-6.75	(.007)
D vs J	3	33.41	(.000)*	14.63	(.001)*
E vs F	3	-5.63	(.011)	-.57	(.608)
E vs I	3	3.48	(.040)	.59	(.597)
E vs J	3	10.20	(.002)*	3.14	(.052)
F vs I	3	6.33	(.008)	2.15	(.121)
F vs J	3	14.13	(.001)*	9.80	(.002)*
I vs J	3	15.90	(.001)*	9.30	(.003)*

Note. * $p < .005$ to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-14

Means and Standard Deviations (in parentheses) for Configuration by Event Interaction on Survivability: Missile Fires

Event	Configuration B	1	3	4
A	5.13 (1.94)	3.54 (1.27)	1.75 (.35)	2.00 (1.02)
C	16.04 (.75)	15.50 (4.37)	3.75 (1.87)	1.67 (.43)
D	4.96 (.64)	4.92 (1.27)	1.25 (.50)	1.08 (.17)
E	13.29 (1.91)	11.25 (2.95)	2.00 (.79)	1.33 (.24)
F	14.33 (3.12)	13.96 (3.65)	2.71 (1.06)	1.98 (.62)
I	11.00 (1.25)	8.00 (1.81)	2.75 (.22)	1.50 (.30)
J	2.42 (.69)	1.29 (.55)	.54 (.21)	.58 (.17)

Note. B = Baseline. *n* = 4. See Table L-16 for significant differences between each pair of configurations.

Table L-15

Means and Standard Deviations (in parentheses) for Configuration by Event Interaction on Survivability: Missile Hits

Event	Configuration B	1	3	4
A	3.96 (1.51)	1.67 (.59)	.21 (.25)	.33 (.56)
C	13.21 (1.77)	5.96 (1.44)	.50 (.49)	.21 (.42)
D	3.50 (.56)	2.41 (.52)	.00 (.00)	.00 (.00)
E	10.00 (3.69)	3.88 (3.99)	.00 (.00)	.00 (.00)
F	9.63 (2.66)	5.08 (1.35)	.38 (.48)	.17 (.33)
I	8.42 (1.14)	2.83 (1.76)	.67 (.38)	.00 (.00)
J	1.71 (.60)	.38 (.25)	.00 (.00)	.08 (.17)

Note. B = Baseline. *n* = 4. See Table L-16 for significant differences between each pair of configurations.

Table L-16

Summary of Bonferroni t tests for Configuration by Event on Survivability: Missile Performance Measures

Event	Comparison	df	Fires		Hits	
			t	(p)	t	(p)
	Configuration					
A	Base vs 1	3	1.03	(.189)	2.28	(.054)
	Base vs 3	3	3.03	(.028)	4.72	(.009)
	Base vs 4	3	3.66	(.018)	5.32	(.007)
	1 vs 3	3	3.37	(.022)	4.01	(.014)
	1 vs 4	3	1.76	(.089)	2.40	(.048)
	3 vs 4	3	-.47	(.666)	-.61	(.708)
C	Base vs 1	3	.22	(.420)	4.74	(.009)
	Base vs 3	3	10.91	(.001)*	14.26	(.000)*
	Base vs 4	3	25.77	(.000)*	12.35	(.000)*
	1 vs 3	3	4.45	(.011)	6.12	(.005)*
	1 vs 4	3	7.01	(.003)*	8.21	(.002)*
	3 vs 4	3	2.04	(.067)*	1.22	(.155)
D	Base vs 1	3	.05	(.965)	2.02	(.069)
	Base vs 3	3	7.12	(.003)*	12.53	(.000)*
	Base vs 4	3	14.47	(.000)*	12.53	(.000)*
	1 vs 3	3	5.31	(.007)	9.37	(.002)*
	1 vs 4	3	5.41	(.006)	9.37	(.002)*
	3 vs 4	3	.58	(.301)*	--	---
E	Base vs 1	3	1.75	(.090)	4.96	(.008)
	Base vs 3	3	14.31	(.000)*	5.42	(.006)
	Base vs 4	3	11.64	(.000)*	5.42	(.006)
	1 vs 3	3	5.82	(.005)*	1.94	(.147)
	1 vs 4	3	6.24	(.004)*	1.94	(.147)
	3 vs 4	3	1.76	(.089)*	--	---
F	Base vs 1	3	.13	(.452)	3.34	(.023)
	Base vs 3	3	5.72	(.006)	5.96	(.005)*
	Base vs 4	3	9.85	(.001)*	7.56	(.003)*
	1 vs 3	3	7.28	(.003)*	6.54	(.004)*
	1 vs 4	3	5.97	(.005)*	6.14	(.005)*
	3 vs 4	3	.88	(.221)*	.58	(.301)*
I	Base vs 1	3	3.91	(.015)	5.41	(.006)
	Base vs 3	3	11.40	(.000)*	11.71	(.000)*
	Base vs 4	3	12.83	(.000)*	14.75	(.000)*
	1 vs 3	3	5.61	(.006)	2.08	(.065)
	1 vs 4	3	6.17	(.005)*	3.22	(.025)
	3 vs 4	3	8.78	(.002)*	3.44	(.021)
J	Base vs 1	3	2.71	(.037)	3.69	(.017)
	Base vs 3	3	4.58	(.010)	5.71	(.006)
	Base vs 4	3	4.61	(.010)	4.58	(.010)
	1 vs 3	3	3.42	(.021)	3.03	(.028)
	1 vs 4	3	2.57	(.041)	1.61	(.104)
	3 vs 4	3	-.36	(.627)	-1.00	(.804)

Note. * $p < .005$, one-tailed, to maintain overall error rate for each set of comparisons at .10 level of significance. -- indicates t test could not be computed due to no variance in both means.

Table L-17

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Survivability: Missile Fires

	Scenario		
Event	A	B	C
A	2.81 (.94)	2.34 (1.01)	4.16 (1.28)
C	9.56 (1.53)	8.65 (1.54)	9.50 (1.90)
D	3.38 (.49)	2.41 (.62)	3.38 (.23)
E	8.97a (1.59)	4.09b (1.35)	7.84 (1.18)
F	6.44a (1.30)	8.03 (1.43)	10.55b (.63)
I	6.22 (.43)	5.53 (1.95)	5.69 (.69)
J	1.44 (.31)	1.44 (.33)	.75 (.59)

Note. $n = 4$. Means in the same row with different letters differ, $p < .005$, Bonferroni t test.

Table L-18

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Survivability: Missile Hits

	Scenario		
Event	A	B	C
A	1.03 (.48)	1.18 (.67)	2.41 (.97)
C	5.63 (1.35)	4.94 (.53)	4.34 (.96)
D	1.21 (.31)	.78 (.45)	2.44 (.41)
E	4.50 (2.08)	2.13 (1.23)	3.78 (2.58)
F	2.78a (1.53)	3.16 (.84)	5.65b (1.20)
I	3.25 (.51)	2.31 (1.39)	3.38 (.71)
J	.63 (.10)	.50 (.31)	.50 (.44)

Note. $n = 4$. Means in the same row with different letters differ, $p < .005$, Bonferroni t test.

Table L-19

Summary of Bonferroni t tests for Scenario by Event on Survivability: Missile Performance Measures

Event	Comparison	df	Fires t	Fires (p)	Hits t	Hits (p)
	Scenario					
A	A vs B	3	.75	(.507)	-.32	(.771)
	A vs C	3	-1.23	(.305)	-1.90	(.153)
	B vs C	3	-2.45	(.092)	-2.64	(.078)
C	A vs B	3	.89	(.441)	.80	(.481)
	A vs C	3	.04	(.970)	1.17	(.328)
	B vs C	3	-1.01	(.388)	1.07	(.362)
D	A vs B	3	1.97	(.143)	1.38	(.262)
	A vs C	3	.00	(1.000)	-3.93	(.029)
	B vs C	3	-2.92	(.061)	-4.21	(.024)
E	A vs B	3	15.31	(.001)*	3.56	(.038)
	A vs C	3	1.13	(.339)	1.00	(.390)
	B vs C	3	-5.25	(.013)	-1.63	(.201)
F	A vs B	3	-2.32	(.103)	-.32	(.767)
	A vs C	3	-10.33	(.002)*	-10.15	(.002)*
	B vs C	3	-5.11	(.015)	-2.57	(.083)
I	A vs B	3	.61	(.583)	1.13	(.342)
	A vs C	3	1.36	(.268)	-.42	(.703)
	B vs C	3	-.14	(.898)	-1.19	(.319)
J	A vs B	3	-.01	(.993)	.92	(.425)
	A vs C	3	1.68	(.192)	.47	(.668)
	B vs C	3	2.86	(.065)	.00	(1.000)

Note. * $p < .005$ to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-20

Means and Standard Deviations (in parentheses) for Main Effects on Survivability: Missile Hit Ranges

Measure	Block 1	Block 2
Hits	2841.63 (181.46)	2802.86 (142.05)
# trials	146	140

Measure	Configuration B	1	3	4
Hits	2930.47 (189.03)	2714.06 (151.04)	2836.41 (693.16)	2056.04 (1783.78)
# trials	153	110	16	7

Measure	Scenario A	B	C
Hits	2619.76 (154.19)	2549.92 (323.42)	3239.85 (77.52)
# trials	101	85	100

Measure	Event A	C	D	E	F	I	J
Hits	1423.69 (225.75)	3175.56 (177.47)	3361.44 (381.25)	2847.44 (77.68)	3122.72 (418.25)	3554.03 (164.63)	1965.24 (148.40)
# trials	45	49	39	36	45	44	28

Measure	Mode Auto	Semi
Hits	2713.94 (213.01)	2654.31 (296.01)
# trials	54	79

Note. B = Baseline (in configuration). n = 4. N = 672 for total number of trials except for Mode in which N = 504. Fifty-seven percent missing data for hits except for Mode in which missing data was 74%.

Table L-21

Summary of Univariate F Tests on Survivability: All Munitions Opening to First Hit Taken

Effect	df	F (p)
Main Effect		
Block (B)	1,3	1.87 (.265)
Config (C)	3,9	8.51 (.005)*
Scene (S)	2,6	7.12 (.026)*
Event (E)	7,21	18.08 (.000)*
Two-way Interactions		
B x C	3,9	.33 (.807)
B x S	2,6	.28 (.766)
B x E	7,21	.28 (.954)
C x S	6,18	2.26 (.084)
C x E	21,63	3.53 (.000)*
S x E	12,36	4.35 (.000)*
Three-way Interactions		
B x C x S	6,18	.96 (.477)
B x C x E	Not able to test	
B x S x E	Not able to test	
C x S x E	Not able to test	
Mode Effects		
Mode (M)	1,3	1.50 (.309)
C x M	2,6	.72 (.523)
C x M x E	14,42	2.43 (.013)*

Note. * $p < .05$ to maintain family-wise error rate at .10 level of significance.

Table L-22

Means and Standard Deviations (in parentheses) for Configuration on Survivability: All Munitions Opening to First Hit Taken

	Configuration			
Measure	B	1	3	4
Opening	75.40 (59.75)	101.69 (24.54)	176.44 (17.21)	163.80 (14.23)

Note. B = Baseline. $n = 4$. See Table L-23 for significant differences between each pair of configurations.

Table L-23

Summary of Bonferroni t tests for Configuration on Survivability: All Munitions Opening to First Hit Taken

Comparison	df	t (p)
Configuration		
Base vs 1	3	-.86 (.273)
Base vs 3	3	-3.76 (.017)*
Base vs 4	3	-2.70 (.037)
1 vs 3	3	-4.27 (.012)*
1 vs 4	3	-8.66 (.002)*
3 vs 4	3	.85 (.228)

Note. * $p < .033$, one-tailed, to maintain overall error rate for the set of comparisons at .10 level of significance.

Table L-24

Means and Standard Deviations (in parentheses) for Scenario on Survivability: All Munitions Opening to First Hit Taken

	Scenario		
Measure	A	B	C
Opening	113.81 (10.10)	115.61 (28.02)	158.21 (29.50)

Note. $n = 4$. Bonferroni t tests could not identify any significant differences between each pair of scenarios.

Table L-25

Summary of Bonferroni t tests for Scenario on Survivability: All Munitions Opening to First Hit Taken

Comparison	df	t (p)
Scenario		
A vs B	3	-.16 (.881)
A vs C	3	-3.15 (.051)
B vs C	3	-2.85 (.065)

Note. * $p < .033$ to maintain overall error rate the set of comparisons at .10 level of significance. No significant differences were found between each pair of scenarios.

Table L-26

Means and Standard Deviations (in parentheses) for Event on Survivability: All Munitions Opening to First Hit Taken

Event							
A	B	C	D	E	F	I	J
87.18 (13.06)	41.44 (18.50)	190.04 (29.32)	67.82 (10.16)	313.47 (49.36)	115.33 (12.20)	103.97 (11.87)	114.25 (100.22)

Note. $n = 4$. See Table L-27 for significant differences between each pair of events.

Table L-27

Summary of Bonferroni t tests for Event on Survivability: All Munitions Opening to First Hit Taken

Comparison	df	t	(p)
Event			
A vs B	3	3.28	(.047)
A vs C	3	-5.44	(.012)
A vs D	3	2.45	(.092)
A vs E	3	-7.88	(.004)*
A vs F	3	-2.39	(.097)
A vs I	3	-1.59	(.209)
A vs J	3	-.49	(.658)
B vs C	3	-9.40	(.003)*
B vs D	3	-3.18	(.050)
B vs E	3	-14.63	(.001)*
B vs F	3	-19.87	(.000)*
B vs I	3	-15.65	(.001)*
B vs J	3	-1.57	(.214)
C vs D	3	6.46	(.008)
C vs E	3	-7.30	(.005)
C vs F	3	5.26	(.013)
C vs I	3	6.25	(.008)
C vs J	3	1.40	(.257)
D vs E	3	-9.37	(.003)*
D vs F	3	-7.44	(.003)*
D vs I	3	-5.38	(.013)
D vs J	3	-.97	(.404)
E vs F	3	9.67	(.002)*
E vs I	3	10.68	(.002)*
E vs J	3	3.65	(.036)
F vs I	3	3.87	(.031)
F vs J	3	.02	(.983)
I vs J	3	-.21	(.848)

Note. * $p < .004$ to maintain overall error rate for the set of comparisons at .10 level of significance.

Table L-28

Means and Standard Deviations (in parentheses) for Configuration by Event Interaction on Survivability: All Munitions Opening to First Hit Taken

	Configuration			
Event	B	1	3	4
A	38.67 (24.04)	53.50 (6.70)	142.25 (27.23)	114.29 (19.12)
B	46.33 (48.51)	43.46 (66.59)	45.96 (22.19)	30.00 (29.37)
C	134.96 (22.20)	154.46 (37.12)	252.33 (62.21)	218.42 (64.15)
D	8.13 (4.68)	36.92 (12.09)	111.67 (22.60)	114.58 (44.30)
E	111.13 (126.46)	264.33 (117.28)	459.00 (61.07)	419.42 (74.97)
F	32.00 (6.62)	95.33 (35.71)	152.38 (33.35)	182.07 (50.15)
I	18.88 (5.44)	83.33 (44.98)	169.17 (49.68)	145.75 (43.29)
J	(213.08) (314.81)	82.21 (40.22)	78.13 (46.94)	83.58 (50.89)

Note. B = Baseline. n = 4. See Table L-29 for significant differences between each pair of configurations.

Table L-29

Summary of Bonferroni t tests for Configuration by Event on Survivability: All Munitions Opening to First Hit Taken

Event	Comparison	df	t (p)
	Configuration		
A	Base vs 1	3	-1.23 (.154)
	Base vs 3	3	-4.84 (.009)
	Base vs 4	3	-4.72 (.009)
	1 vs 3	3	-8.17 (.002)*
	1 vs 4	3	-9.60 (.001)*
	3 vs 4	3	5.16 (.993)
B	Base vs 1	3	-.06 (.478)
	Base vs 3	3	.02 (.507)
	Base vs 4	3	.82 (.765)
	1 vs 3	3	-.06 (.478)
	1 vs 4	3	.32 (.616)
	3 vs 4	3	.86 (.773)
C	Base vs 1	3	-1.07 (.182)
	Base vs 3	3	-3.29 (.023)
	Base vs 4	3	-2.10 (.063)
	1 vs 3	3	-5.14 (.007)
	1 vs 4	3	-1.72 (.092)
	3 vs 4	3	.88 (.778)
D	Base vs 1	3	-4.15 (.013)
	Base vs 3	3	-8.48 (.002)*
	Base vs 4	3	-4.53 (.010)
	1 vs 3	3	-13.64 (.000)*
	1 vs 4	3	-3.11 (.027)
	3 vs 4	3	-.10 (.463)
E	Base vs 1	3	-1.80 (.085)
	Base vs 3	3	-5.41 (.006)
	Base vs 4	3	-3.82 (.016)
	1 vs 3	3	-2.41 (.048)
	1 vs 4	3	-2.54 (.043)
	3 vs 4	3	1.15 (.833)
F	Base vs 1	3	-3.33 (.023)
	Base vs 3	3	-7.34 (.003)*
	Base vs 4	3	-6.62 (.004)*
	1 vs 3	3	-2.31 (.052)*
	1 vs 4	3	-2.12 (.062)*
	3 vs 4	3	-.98 (.201)
I	Base vs 1	3	-2.60 (.040)
	Base vs 3	3	-5.54 (.006)
	Base vs 4	3	-6.63 (.004)*
	1 vs 3	3	-3.46 (.021)
	1 vs 4	3	-1.55 (.110)
	3 vs 4	3	.54 (.687)
J	Base vs 1	3	.95 (.793)
	Base vs 3	3	.84 (.768)
	Base vs 4	3	.97 (.799)
	1 vs 3	3	.11 (.541)
	1 vs 4	3	-.10 (.464)
	3 vs 4	3	-.17 (.437)

Note. * $p < .004$, one-tailed, to maintain overall error rate for the set of comparisons at .10 level of significance.

Table L-30

Means and Standard Deviation) (in parentheses) for Scenario by Event Interaction on Survivability: All Munitions Opening to First Hit Taken

	Scenario		
Event	A	B	C
A	114.09 (32.82)	90.28 (22.56)	57.16 (29.73)
B	38.06 (50.43)	55.16 (52.89)	31.09 (20.50)
C	68.16 (26.03)	127.16 (22.06)	374.81 (107.79)
D	94.41 (22.36)	62.38 (11.39)	46.69 (10.04)
E	365.91 (72.07)	181.75 (100.52)	392.75 (95.40)
F	90.34 (16.14)	86.56 (5.57)	170.92 (29.02)
I	96.50 (17.18)	90.28 (44.40)	124.59 (46.55)
J	43.03 (16.99)	230.84 (293.90)	68.88 (17.99)

Note. *n* = 4. Bonferroni *t* tests could not identify any significant differences between each pair of scenarios.

Table L-31

Summary of Bonferroni t tests for Scenario by Event on Survivability: All Munitions Opening to First Hit Taken

Event	Comparison	df	t (p)
	Scenario		
A	A vs B	3	1.50 (.231)
	A vs C	3	2.04 (.134)
	B vs C	3	1.59 (.211)
B	A vs B	3	-.37 (.735)
	A vs C	3	.24 (.825)
	B vs C	3	.99 (.396)
C	A vs B	3	-4.94 (.016)
	A vs C	3	-5.15 (.014)
	B vs C	3	-3.93 (.029)
D	A vs B	3	-3.38 (.043)
	A vs C	3	4.17 (.025)
	B vs C	3	1.60 (.207)
E	A vs B	3	2.91 (.062)
	A vs C	3	-.49 (.657)
	B vs C	3	-2.76 (.070)
F	A vs B	3	.41 (.707)
	A vs C	3	-6.41 (.008)
	B vs C	3	-5.00 (.015)
I	A vs B	3	.21 (.846)
	A vs C	3	-1.11 (.347)
	B vs C	3	-.88 (.442)
J	A vs B	3	-1.28 (.290)
	A vs C	3	-1.53 (.223)
	B vs C	3	-1.12 (.344)

Note. * p < .004 to maintain overall error rate for the set of comparisons at .10 level of significance. No significant differences were found between each pair of scenarios.

Table L-32

Means and Standard Deviations (in parentheses) for Configuration by Mode by Event on Survivability: All Munitions Opening to First Hit Taken

Event	Mode	Configuration 1	3	4
A	Auto	48.42 (17.94)	173.50 (36.25)	129.00 (47.18)
	Semi	58.58 (27.57)	111.00 (28.57)	99.58 (10.34)
B	Auto	11.33 (9.65)	32.83 (19.43)	46.00 (57.98)
	Semi	75.58 (127.90)	59.08 (63.05)	14.00 (14.05)
C	Auto	161.08 (59.40)	223.83 (113.48)	237.50 (13.66)
	Semi	147.83 (104.83)	280.83 (30.71)	199.33 (120.16)
D	Auto	41.58 (34.99)	99.75 (14.23)	123.83 (87.24)
	Semi	32.25 (15.70)	123.58 (40.23)	105.33 (16.00)
E	Auto	422.67 (194.11)	451.08 (100.17)	432.42 (44.69)
	Semi	106.00 (96.72)	466.92 (49.08)	406.42 (109.86)
F	Auto	81.83 (30.29)	117.08 (34.24)	164.83 (40.56)
	Semi	108.83 (71.74)	187.67 (57.47)	197.38 (70.08)
I	Auto	79.83 (27.72)	152.04 (72.82)	169.42 (82.43)
	Semi	86.83 (94.13)	180.17 (109.53)	122.08 (21.56)
J	Auto	89.83 (33.40)	95.17 (61.04)	90.17 (29.08)
	Semi	74.58 (63.17)	61.08 (33.39)	77.00 (82.73)

Note. n = 4. No significance tests were performed on the three-way interaction.

Table L-33

Frequency Distribution of Survivability: Fratricide Measures by Configuration

	Configuration			
Measure	B	1	3	4
Lases	38	36	25	36
Fires	15	22	9	18
Hits	1	2	8	14
Hits	1	1	1	2

Note. B = Baseline. *N* = 960 for total number of trials.

Table L-34

Frequency Distribution of Survivability: Fratricide Measures (VIDS Only) by Configuration

	Configuration			
Measure	B	1	3	4
CPS Engages	N/A	N/A	7	11
CPS Hits	N/A	N/A	0	1

Note. B = Baseline. *N* = 960 for total number of trials.

Table L-35

Summary of Univariate F Tests on Lethality: Detection Performance Measures

Effect	df	Beg2tac F	(p)	Tac2fire F	(p)	Range F	(p)
Main Effect							
Block (B)	1,3	19.41	(.022)	1.24	(.347)	3.26	(.169)
Config (C)	3,9	4.45	(.035)	5.02	(.026)	8.80	(.005)*
Scene (S)	2,6	2.20	(.191)	7.48	(.023)	21.33	(.002)*
Event (E)	9,27	7.72	(.000)*	6.95	(.000)*	75.70	(.000)*
Two-way Interactions							
B x C	3,9	1.53	(.273)	.67	(.594)	2.76	(.104)
B x S	2,6	3.91	(.082)	6.58	(.031)	.22	(.812)
B x E	9,27	2.09	(.067)	.73	(.679)	.53	(.843)
C x S	6,18	2.01	(.117)	1.10	(.400)	.69	(.664)
C x E		Not able to test					
S x E	18,54	4.36	(.000)*	3.11	(.001)*	10.29	(.000)*
Three-way Interactions							
B x C x S	6,18	1.51	(.232)	1.48	(.240)	.57	(.745)
B x C x E		Not able to test					
B x S x E	18,54	2.08	(.020)	4.74	(.000)*	.33	(.325)
C x S x E		Not able to test					
Mode Effects							
Mode (M)	1,3	.37	(.584)	.03	(.870)	2.61	(.205)
C x M	2,6	.72	(.523)	.09	(.916)	.01	(.990)
C x M x E		Not able to test					

Note. * $p < .016$ to maintain family-wise error rate for this group of dependent variables at .10 level of significance.

Table L-36

Means and Standard Deviations (in parentheses) for Configuration on Lethality: Detection Performance Measures

Measure	Configuration B	1	3	4
Beg2tac	217.45 (47.02)	200.72 (53.02)	108.86 (47.18)	116.64 (45.48)
Tac2fire	40.98 (28.66)	20.32 (5.76)	81.92 (39.86)	71.22 (49.31)
Range	2515.10 (97.90)	2556.41 (101.69)	2443.70a (98.93)	2517.30b (122.69)

Note. B = Baseline. $n = 4$. Means in the same row with different letters differ, $p < .033$, one-tailed Bonferroni t test.

Table L-37

Summary of Bonferroni t tests for Configuration on Lethality: Detection Ranges

Comparison	df	t (p)
Configuration		
Base vs 1	3	-1.73 (.091)
Base vs 3	3	17.46(1.000)
Base vs 4	3	-.08 (.470)
1 vs 3	3	5.63 (.995)
1 vs 4	3	1.70 (.906)
3 vs 4	3	-3.03 (.028)*

Note. * $p < .033$, one-tailed to maintain overall error rate for the set of comparisons at .10 level of significance.

Table L-38

Means and Standard Deviations (in parentheses) for Scenario on Lethality: Detection Ranges

	Scenario		
Measure	A	B	C
Range	2427.19a (115.08)	2407.12a (91.39)	2690.06b (142.66)

Note. $n = 4$. Means in the same row with different letters differ, $p < .033$, Bonferroni t test.

Table L-39

Summary of Bonferroni t tests for Scenario on Lethality: Detection Ranges

	Range	
Comparison	df	t (p)
Scenario		
A vs B	3	.45 (.686)
A vs C	3	-4.04 (.027)*
B vs C	3	-7.08 (.006)*

Note. * $p < .033$ to maintain overall error rate the set of comparisons at .10 level of significance.

Table L-40

Means and Standard Deviations (in parentheses) for Event on Lethality: Detection Performance Measures

Measure	Event A	B	C	D	E
Beg2tac	125.38 (27.93)	202.30 (70.76)	156.55 (23.51)	47.56 (60.19)	355.62 (68.47)
Tac2fire	23.61 (9.47)	21.77 (20.25)	32.88 (11.94)	82.35 (48.66)	29.24 (21.36)
Range	1952.10 (248.20)	1089.43 (180.90)	2895.98 (136.55)	2499.08 (74.22)	3078.16 (84.87)

Measure	Event F	G	H	I	J
Beg2tac	57.69 (41.20)	248.94 (48.64)	162.93 (38.04)	20.34 (157.14)	216.87 (79.83)
Tac2fire	100.42 (47.57)	19.37 (12.09)	13.79 (6.76)	186.76 (129.97)	30.35 (11.02)
Range	2499.15 (259.22)	2943.43 (106.33)	2787.90 (59.06)	2674.85 (122.46)	2611.65 (180.27)

Note. n = 4. See Table L-40 for significant differences between each pair of events.

Table L-41

Summary of Bonferroni t tests for Event on Lethality: Detection Performance Measures

Comparison	df	Beg2tac t	(p)	Tac2fire t	(p)	Range t	(p)
Event							
A vs B	3	-1.96	(.145)	.17	(.879)	15.93	(.001)*
A vs C	3	-1.29	(.287)	-1.04	(.374)	-7.03	(.006)
A vs D	3	2.04	(.134)	-2.45	(.092)	-3.56	(.038)
A vs E	3	-9.80	(.002)*	-.47	(.672)	-11.84	(.001)*
A vs F	3	3.03	(.056)	-2.95	(.060)	-3.69	(.035)
A vs G	3	-7.48	(.005)	.65	(.564)	-10.58	(.002)*
A vs H	3	-6.07	(.009)	2.39	(.097)	-8.17	(.004)
A vs I	3	1.21	(.314)	-2.48	(.089)	-9.34	(.003)
A vs J	3	-1.86	(.159)	-.79	(.488)	-5.81	(.010)
B vs C	3	1.25	(.300)	-1.12	(.343)	-16.34	(.000)*
B vs D	3	2.46	(.090)	-3.00	(.057)	-12.60	(.001)*
B vs E	3	-3.59	(.037)	-3.50	(.039)	-25.52	(.000)*
B vs F	3	2.62	(.079)	-3.26	(.047)	-9.57	(.002)*
B vs G	3	-1.61	(.207)	.42	(.700)	-23.50	(.000)*
B vs H	3	1.01	(.385)	1.02	(.385)	-25.06	(.000)*
B vs I	3	1.69	(.190)	-2.79	(.068)	-21.88	(.000)*
B vs J	3	-.31	(.776)	-1.35	(.271)	-21.52	(.000)*
C vs D	3	3.62	(.036)	-2.51	(.087)	5.16	(.014)
C vs E	3	-4.51	(.020)	.39	(.719)	-2.10	(.127)
C vs F	3	4.29	(.023)	-3.77	(.033)	2.13	(.123)
C vs G	3	-2.82	(.067)	2.35	(.100)	-.46	(.674)
C vs H	3	-.22	(.843)	2.50	(.087)	1.25	(.300)
C vs I	3	1.88	(.157)	-2.59	(.081)	2.53	(.085)
C vs J	3	-1.41	(.254)	.32	(.768)	3.62	(.036)
D vs E	3	-5.72	(.011)	2.85	(.065)	-7.31	(.005)
D vs F	3	-.44	(.688)	-1.08	(.360)	.00	(1.000)
D vs G	3	-3.81	(.032)	3.27	(.047)	-5.03	(.015)
D vs H	3	-2.66	(.076)	2.88	(.063)	-4.94	(.016)
D vs I	3	.51	(.643)	-2.46	(.091)	-1.80	(.170)
D vs J	3	-3.87	(.030)	2.13	(.123)	-1.24	(.304)
E vs F	3	6.87	(.006)	-3.21	(.049)	5.72	(.011)
E vs G	3	5.36	(.013)	1.68	(.191)	8.69	(.003)
E vs H	3	10.61	(.002)*	1.73	(.183)	9.21	(.003)
E vs I	3	3.16	(.051)	-2.75	(.071)	16.79	(.000)*
E vs J	3	2.78	(.069)	-.15	(.888)	4.38	(.022)
F vs G	3	-4.99	(.015)	3.69	(.034)	-5.10	(.015)
F vs H	3	-3.76	(.033)	3.41	(.042)	-2.54	(.085)
F vs I	3	.57	(.611)	-1.86	(.159)	-1.60	(.207)
F vs J	3	-2.94	(.060)	2.84	(.066)	-.57	(.610)
G vs H	3	6.73	(.007)	1.21	(.314)	4.31	(.023)
G vs I	3	2.24	(.111)	-2.79	(.069)	8.91	(.003)
G vs J	3	.61	(.582)	-1.81	(.167)	2.86	(.065)
H vs I	3	1.53	(.223)	-2.67	(.075)	2.28	(.107)
H vs J	3	-1.06	(.365)	-3.68	(.035)	2.00	(.139)
I vs J	3	-2.23	(.112)	2.46	(.091)	.59	(.596)

Note. * $p < .002$ to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-42

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Detection Beg2tac

	Scenario		
Event	A	B	C
A	117.52 (44.95)	102.00 (21.04)	156.45 (39.65)
B	200.68 (128.61)	252.31 (53.83)	153.15 (45.61)
C	195.36 (69.99)	86.91 (33.76)	379.17 (56.30)
D	31.83 (62.07)	-2.33 (106.99)	101.53 (13.74)
E	483.14 (111.64)	330.56 (149.45)	259.13 (64.36)
F	97.67 (12.67)	52.05 (79.24)	58.62 (166.40)
G	170.90a (36.01)	280.44b (42.14)	290.21 (85.20)
H	65.26 (8.92)	170.69 (38.00)	247.66 (74.71)
I	190.35 (41.09)	.07 (261.06)	-123.69 (191.06)
J	221.29 (98.27)	367.32 (250.17)	78.22 (6.60)

Note. $\underline{n} = 4$. Means in the same row with different letters differ, $\underline{p} < .003$, Bonferroni $\underline{t}$ test.

Table L-43

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Detection Tac2fire

	Scenario		
Event	A	B	C
A	26.98 (11.79)	16.40 (11.33)	28.17 (26.68)
B	27.17 (26.25)	18.76 (11.61)	18.26 (26.43)
C	19.01 (11.75)	31.53 (13.07)	111.83 (50.61)
D	82.64 (49.43)	110.49 (94.98)	53.43 (9.55)
E	50.47 (33.04)	10.56 (5.48)	27.81 (34.45)
F	51.25 (48.37)	86.34 (84.50)	149.67 (109.25)
G	25.86 (20.80)	13.66 (8.07)	19.79 (13.97)
H	16.06 (23.95)	11.00 (8.39)	13.75 (5.50)
I	45.51 (11.98)	267.38 (220.11)	235.72 (169.95)
J	18.59 (9.89)	66.76 (19.16)	8.28 (3.30)

Note. n = 4. Bonferroni t tests could not identify any significant differences between each pair of scenarios.

Table L-44

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Detection Range

	Scenario		
Event	A	B	C
A	2234.30 (423.42)	2509.23 (360.74)	1154.93 (446.97)
B	816.52 (52.65)	1390.84 (233.61)	1002.83 (366.68)
C	2890.20 (248.91)	2916.67 (164.27)	2396.56 (1740.90)
D	2326.59 (418.65)	1864.56 (428.16)	3110.50 (200.32)
E	3219.78 (26.30)	2684.11 (203.26)	3338.36 (41.91)
F	2202.53 (497.58)	2426.08 (34.59)	2949.93 (154.94)
G	2883.22 (116.10)	2654.28 (43.62)	3301.58 (247.39)
H	2308.74a (97.69)	2723.86a (29.73)	3297.61b (123.33)
I	2874.87a (208.30)	2279.01b (151.32)	2864.38 (251.81)
J	2203.41 (141.95)	2547.86 (211.77)	3014.72 (365.07)

Note. n = 4. Means in the same row with different letters differ, p < .003, Bonferroni t test.

Table L-45

Summary of Bonferroni t tests for Scenario by Event Interaction on Lethality: Detection Performance Measures

			Beg2tac		Tac2fire		Range	
Event	Comparison	df	t	(p)	t	(p)	t	(p)
	Scenario							
A	A vs B	3	.72	(.524)	1.37	(.263)	-2.20	(.115)*
	A vs C	3	-2.69	(.075)	-.08	(.942)	3.21	(.049)
	B vs C	3	-3.02	(.057)	-.78	(.493)	5.19	(.014)
B	A vs B	3	-1.01	(.389)	.85	(.460)	-4.44	(.021)
	A vs C	3	1.08	(.360)	2.43	(.093)	-1.10	(.353)
	B vs C	3	5.64	(.011)	.05	(.960)	2.06	(.132)
C	A vs B	3	2.44	(.092)	-1.73	(.181)	-.45	(.682)
	A vs C	3	-3.74	(.065)	-2.46	(.133)	.47	(.685)
	B vs C	3	-6.12	(.026)	-2.35	(.144)	.53	(.651)
D	A vs B	3	--	---	-.88	(.445)	1.21	(.313)
	A vs C	3	-2.74	(.071)	1.36	(.268)	-3.81	(.032)
	B vs C	3	--	---	1.30	(.283)	-4.42	(.022)
E	A vs B	3	2.82	(.067)	2.30	(.105)	5.69	(.011)
	A vs C	3	2.67	(.076)	3.72	(.034)	-4.81	(.017)
	B vs C	3	.78	(.494)	-1.00	(.390)	-6.94	(.006)
F	A vs B	3	1.15	(.333)	-.66	(.557)	-.88	(.445)
	A vs C	3	--	---	-2.45	(.092)	-3.69	(.037)
	B vs C	3	--	---	-.78	(.493)	-6.67	(.007)
G	A vs B	3	-10.00	(.002)*	1.49	(.233)	2.93	(.061)
	A vs C	3	-3.47	(.040)	.61	(.584)	-6.35	(.008)
	B vs C	3	-.24	(.824)	-1.45	(.243)	-4.51	(.020)
H	A vs B	3	-6.48	(.007)	.37	(.736)	-8.04	(.004)
	A vs C	3	-5.42	(.012)	.16	(.882)	-11.41	(.001)*
	B vs C	3	-3.58	(.037)	-.97	(.405)	-11.44	(.001)*
I	A vs B	3	--	---	-2.18	(.117)	18.19	(.000)*
	A vs C	3	--	---	-2.38	(.098)	.06	(.956)
	B vs C	3	--	---	.81	(.476)	-3.70	(.034)
J	A vs B	3	-.91	(.429)	.17	(.879)	-2.57	(.082)
	A vs C	3	3.06	(.055)	-1.04	(.374)	-3.79	(.032)
	B vs C	3	2.32	(.057)	-2.45	(.092)	-4.38	(.022)

Note. * $p < .003$ to maintain overall error rate for each set of comparisons at .10 level of significance. -- indicates t test could not be accurately computed by SPSS/PC+ due to negative values in the measures.

Table L-46

Summary of Univariate F Tests on Lethality: Acquisition and Engagement Performance Measures

		Gunnery		Cathits		Killtime	
Effect	df	F	(p)	F	(p)	F	(p)
Main Effect							
Block (B)	1,3	.07	(.809)	.11	(.762)	3.72	(.149)
Config (C)	3,9	3.43	(.066)	19.48	(.000)*	1.52	(.275)
Scene (S)	2,6	.31	(.747)	1.21	(.363)	1.85	(.237)
Event (E)	9,27	23.96	(.000)*	517.34	(.000)*	206.71	(.000)*
Two-way Interactions							
B x C	3,9	.16	(.922)	.36	(.786)	2.73	(.106)
B x S	2,6	2.58	(.155)	.17	(.850)	1.71	(.258)
B x E	9,27	.70	(.702)	.80	(.623)	1.04	(.432)
C x S	6,18	.84	(.553)	.99	(.462)	.88	(.530)
C x E	27,81	1.49	(.088)	14.84	(.000)*	2.12	(.005)*
S x E	18,54	4.21	(.000)*	5.85	(.000)*	3.96	(.000)*
Three-way Interactions							
B x C x S	6,18	.97	(.472)	.59	(.734)	.99	(.462)
B x C x E				Not able to test			
B x S x E	18,54	1.55	(.109)	.45	(.967)	1.86	(.041)
C x S x E				Not able to test			
Mode Effects							
Mode (M)	1,3	.33	(.604)	.79	(.440)	.00	(.993)
C x M	2,6	.93	(.445)	9.07	(.015)*	2.41	(.171)
C x M x E				Not able to test			

Note. * $p < .017$ to maintain family-wise error rate for this group of dependent variables at .10 level of significance.

Table L-47

Means and Standard Deviations (in parentheses) for Configuration on Lethality: Acquisition and Engagement Performance Measures

	Configuration			
Measure	B	1	3	4
Gunnery	.46 (.05)	.44 (.05)	.39 (.04)	.42 (.02)
Cathits	2.97 (.09)	3.03 (.11)	2.59 (.09)	2.56 (.24)
Killtime	76.23 (9.56)	69.50 (7.96)	67.50 (14.20)	63.92 (2.80)

Note. B = Baseline. $n = 4$. One-tailed Bonferroni t tests could not identify any significant differences between each pair of configurations.

Table L-48

Summary of Bonferroni t tests for Configuration on Lethality: Acquisition and Engagement Catastrophic Kills

Comparison	df	t (p)
Configuration		
Base vs 1	3	-2.00 (.070)
Base vs 3	3	7.49 (.998)
Base vs 4	3	4.62 (.991)
1 vs 3	3	5.54 (.994)
1 vs 4	3	4.56 (.990)
3 vs 4	3	.28 (.602)

Note. * $p < .033$, one-tailed, to maintain overall error rate for the set of comparisons at .10 level of significance. No significant differences were found between pairs of configurations.

Table L-49

Means and Standard Deviations (in parentheses) for Event on Lethality: Acquisition and Engagement Performance Measures

Measure	Event A	Event B	Event C	Event D	Event E
Gunnery	.53 (.09)	.78 (.05)	.37 (.06)	.42 (.12)	.33 (.03)
Cathits	1.96 (.03)	2.52 (.09)	2.24 (.24)	1.00 (.00)	7.91 (.50)
Killtime	39.60 (8.45)	23.63 (3.61)	37.99 (10.25)	4.15 (4.91)	325.86 (36.54)

Measure	Event F	Event G	Event H	Event I	Event J
Gunnery	.27 (.05)	.35 (.02)	.34 (.03)	.32 (.05)	.45 (.13)
Cathits	2.17 (.12)	2.88 (.10)	2.95 (.04)	1.79 (.05)	1.00 (.00)
Killtime	24.78 (11.52)	74.01 (9.50)	57.75 (9.00)	29.28 (15.83)	1.67 (3.35)

Note. $n = 4$. See Table L-50 for significant differences between each pair of events.

Table L-50

Summary of Bonferroni t tests for Event on Lethality: Acquisition and Engagement Performance Measures

Comparison	df	Gunnery t	Gunnery (p)	Cathits t	Cathits (p)	Killtime t	Killtime (p)
Event							
A vs B	3	-7.47	(.005)	-9.06	(.003)	5.49	(.012)
A vs C	3	2.32	(.103)	-2.36	(.099)	.20	(.854)
A vs D	3	1.31	(.281)	58.79	(.000)*	9.00	(.003)
A vs E	3	5.85	(.010)	-22.68	(.000)*	-18.01	(.000)*
A vs F	3	10.52	(.002)*	-3.12	(.052)	3.43	(.042)
A vs G	3	4.78	(.017)	-22.42	(.000)*	-4.05	(.027)
A vs H	3	4.02	(.028)	-31.93	(.000)*	-5.36	(.013)
A vs I	3	4.80	(.017)	4.90	(.016)	2.02	(.136)
A vs J	3	2.24	(.111)	58.79	(.000)*	9.28	(.003)
B vs C	3	8.56	(.003)	2.04	(.134)	-2.35	(.100)
B vs D	3	6.82	(.006)	33.04	(.000)*	11.12	(.002)*
B vs E	3	31.51	(.000)*	-23.63	(.000)*	-16.78	(.000)*
B vs F	3	49.23	(.000)*	9.36	(.003)	-.26	(.810)
B vs G	3	19.00	(.000)*	-3.88	(.030)	-7.78	(.004)
B vs H	3	19.39	(.000)*	-9.11	(.003)	-7.52	(.005)
B vs I	3	24.35	(.000)*	18.21	(.000)*	-.86	(.455)
B vs J	3	6.82	(.006)	33.04	(.000)*	7.80	(.004)
C vs D	3	-.96	(.408)	10.45	(.002)*	4.70	(.018)
C vs E	3	.99	(.393)	-25.52	(.000)*	-15.65	(.001)*
C vs F	3	1.87	(.158)	.42	(.703)	1.85	(.161)
C vs G	3	.41	(.710)	-8.11	(.004)	-5.44	(.012)
C vs H	3	1.57	(.215)	-6.24	(.008)	-2.55	(.084)
C vs I	3	.76	(.504)	3.56	(.038)	.96	(.409)
C vs J	3	-1.29	(.288)	10.45	(.002)*	6.66	(.007)
D vs E	3	1.68	(.192)	-27.59	(.000)*	-16.52	(.000)*
D vs F	3	2.47	(.090)	-20.75	(.000)*	-3.61	(.036)
D vs G	3	1.13	(.340)	-37.23	(.000)*	-11.24	(.002)*
D vs H	3	2.79	(.068)	-94.70	(.000)*	-9.67	(.002)*
D vs I	3	1.43	(.247)	-33.73	(.000)*	-3.13	(.052)
D vs J	3	-.49	(.656)	--	---	.67	(.548)
E vs F	3	4.62	(.019)	27.57	(.000)*	17.48	(.000)*
E vs G	3	-2.89	(.063)	19.76	(.000)*	12.31	(.001)*
E vs H	3	.59	(.600)	20.91	(.000)*	18.64	(.000)*
E vs I	3	-1.73	(.182)	25.66	(.000)*	20.66	(.000)*
E vs J	3	-3.38	(.043)	27.59	(.000)*	19.11	(.000)*
F vs G	3	-4.38	(.022)	-7.95	(.004)	-4.72	(.018)
F vs H	3	-1.42	(.249)	-13.22	(.001)*	-4.82	(.017)
F vs I	3	-3.93	(.029)	6.77	(.007)	-1.45	(.244)
F vs J	3	-5.40	(.012)	20.75	(.000)*	3.62	(.036)
G vs H	3	1.46	(.239)	-1.33	(.277)	2.27	(.108)
G vs I	3	1.10	(.353)	18.06	(.000)*	3.59	(.037)
G vs J	3	-2.72	(.073)	37.23	(.000)*	15.59	(.001)*
H vs I	3	-1.31	(.281)	112.78	(.000)*	3.98	(.028)
H vs J	3	-2.60	(.080)	94.70	(.000)*	17.93	(.000)*
I vs J	3	-2.57	(.082)	33.73	(.000)*	3.47	(.040)

Note. * p < .002 to maintain overall error rate for each set of comparisons at .10 level of significance. -- indicates t test could not be computed due to no variance in both means.

Table L-51

Means and Standard Deviations (in parentheses) for Configuration by Event Interaction on Lethality: Acquisition and Engagement CATHits

	Configuration			
Event	B	1	3	4
A	1.96 (.08)	1.96 (.08)	2.00 (.00)	1.92 (.10)
B	2.75 (.17)	2.71 (.16)	2.46 (.32)	2.10 (.23)
C	2.56 (.43)	2.52 (.27)	1.84 (.35)	1.94 (.42)
D	1.00 (.00)	1.00 (.00)	1.00 (.00)	1.00 (.00)
E	9.33 (.27)	9.67 (.19)	6.46 (.72)	6.17 (1.15)
F	2.47 (.27)	2.63 (.36)	1.44 (.31)	1.48 (.41)
G	2.76 (.25)	2.91 (.11)	2.92 (.10)	2.92 (.17)
H	2.87 (.16)	2.96 (.16)	3.00 (.00)	2.96 (.08)
I	1.70 (.21)	2.00 (.00)	1.60 (.36)	1.81 (.24)
J	1.00 (.00)	1.00 (.00)	1.00 (.00)	1.00 (.00)

Note. B = Baseline. n = 4. One-tailed Bonferroni t tests could not identify any significant differences between each pair of configurations within an event.

Table L-52

Means and Standard Deviations (in parentheses) for Configuration by Event Interaction on Lethality: Acquisition and Engagement Killtime

	Configuration			
Event	B	1	3	4
A	31.13 (9.67)	55.54 (18.34)	41.50 (12.41)	30.25 (6.27)
B	28.46a (6.44)	25.92 (11.04)	26.33 (8.58)	12.44b (4.14)
C	51.65 (27.15)	53.63 (21.96)	13.33 (6.34)	32.79 (45.49)
D	6.56 (13.13)	.00 (.00)	.00 (.00)	9.60 (19.20)
E	413.17 (45.16)	320.83 (60.02)	284.54 (80.93)	284.92 (89.28)
F	23.52 (4.62)	41.43 (36.25)	10.50 (10.83)	9.15 (6.33)
G	57.65 (6.09)	71.65 (43.48)	74.79 (17.48)	91.63 (43.67)
H	54.27 (31.22)	41.13 (36.25)	90.67 (36.39)	45.13 (15.75)
I	22.37 (9.76)	50.61 (56.73)	23.82 (33.07)	11.06 (5.96)
J	.00 (.00)	6.42 (12.83)	.00 (.00)	.00 (.00)

Note. B = Baseline. n = 4. See Table L-53 for significant differences between each pair of configurations.

Table L-53

Summary of Bonferroni t tests for Configuration by Event on Lethality: Acquisition and Engagement Cathits and Killtime

			Cathits		Killtime	
Event	Comparison	df	t	(p)	t	(p)
	Configuration					
A	Base vs 1	3	.00	(.500)	-3.02	(.972)
	Base vs 3	3	-1.00	(.196)	-1.15	(.833)
	Base vs 4	3	.52	(.681)	.21	(.423)
	1 vs 3	3	-1.00	(.196)	1.76	(.089)
	1 vs 4	3	1.00	(.805)	2.92	(.031)
	3 vs 4	3	1.73	(.909)	1.90	(.077)
B	Base vs 1	3	.27	(.597)	.30	(.391)
	Base vs 3	3	2.05	(.934)	.38	(.363)
	Base vs 4	3	3.45	(.980)	6.87	(.003)*
	1 vs 3	3	1.19	(.841)	-.08	(.528)
	1 vs 4	3	6.55	(.997)	1.98	(.929)
	3 vs 4	3	2.03	(.932)	3.92	(.015)
C	Base vs 1	3	.30	(.609)	-.09	(.532)
	Base vs 3	3	2.93	(.970)	2.92	(.031)
	Base vs 4	3	2.13	(.934)	.55	(.310)
	1 vs 3	3	2.81	(.966)	3.27	(.024)
	1 vs 4	3	2.23	(.944)	1.75	(.089)
	3 vs 4	3	-1.05	(.189)	-.80	(.760)
D	Base vs 1	3	--	---	1.00	(.195)
	Base vs 3	3	--	---	1.00	(.195)
	Base vs 4	3	--	---	-.23	(.583)
	1 vs 3	3	--	---	--	---
	1 vs 4	3	--	---	-1.00	(.805)
	3 vs 4	3	--	---	-1.00	(.805)
E	Base vs 1	3	-3.46	(.021)	2.74	(.036)
	Base vs 3	3	8.23	(.998)	3.18	(.025)
	Base vs 4	3	6.46	(.996)	1.92	(.075)
	1 vs 3	3	11.31	(1.000)	1.64	(.010)
	1 vs 4	3	6.75	(.997)	.63	(.289)
	3 vs 4	3	.60	(.706)	-.01	(.502)
F	Base vs 1	3	-.73	(.258)	-.91	(.784)
	Base vs 3	3	4.30	(.989)	1.80	(.085)
	Base vs 4	3	3.74	(.984)	3.56	(.019)
	1 vs 3	3	6.93	(.997)	2.31	(.052)
	1 vs 4	3	3.56	(.981)	1.84	(.081)
	3 vs 4	3	-.21	(.422)	.32	(.386)
G	Base vs 1	3	-1.47	(.120)	-.63	(.715)
	Base vs 3	3	-1.07	(.181)	-1.90	(.923)
	Base vs 4	3	-.99	(.197)	-1.47	(.882)
	1 vs 3	3	-.12	(.456)	-.11	(.541)
	1 vs 4	3	-.14	(.450)	-.60	(.705)
	3 vs 4	3	.00	(.502)	-.60	(.704)
H	Base vs 1	3	-.64	(.284)	.52	(.319)
	Base vs 3	3	-1.63	(.101)	-1.85	(.920)
	Base vs 4	3	-1.72	(.092)	.62	(.289)
	1 vs 3	3	-.52	(.319)	-1.87	(.921)
	1 vs 4	3	.00	(.500)	-.25	(.591)
	3 vs 4	3	1.00	(.805)	1.93	(.075)

(*table continues*)

Event	Comparison	df	Cathits t	Cathits (p)	Killtime t	Killtime (p)
	Configuration					
I	Base vs 1	3	-2.78	(.035)	-.94	(.792)
	Base vs 3	3	.54	(.314)	-.08	(.530)
	Base vs 4	3	-.51	(.322)	2.40	(.048)
	1 vs 3	3	2.23	(.056)	.69	(.269)
	1 vs 4	3	1.57	(.108)	1.49	(.116)
	3 vs 4	3	-.76	(.251)	.67	(.277)
J	Base vs 1	3	--	---	-1.00	(.805)
	Base vs 3	3	--	---	--	---
	Base vs 4	3	--	---	--	---
	1 vs 3	3	--	---	1.00	(.120)
	1 vs 4	3	--	---	1.00	(.120)
	3 vs 4	3	--	---	--	---

Note. * p < .003, one-tailed, to maintain overall error rate for each set of comparisons at .10 level of significance. -- indicates t test could not be computed due to no variance in both means.

Table L-54

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Acquisition and Engagement Gunnery

Event	Scenario A	Scenario B	Scenario C
A	.55 (.16)	.41 (.03)	.64 (.08)
B	.79 (.09)	.68 (.09)	.85 (.02)
C	.35 (.02)	.37 (.07)	1.00 (.00)
D	.24 (.18)	.62 (.12)	.34 (.16)
E	.30 (.03)	.39 (.04)	.29 (.09)
F	.28 (1.29)	.21 (.06)	.30 (.04)
G	.36 (.06)	.41 (.03)	.28 (.11)
H	.44 (.08)	.30 (.04)	.27 (.02)
I	.25 (.04)	.34 (.08)	.37 (.12)
J	.45 (.11)	.55 (.55)	.35 (.11)

Note. n = 4. Bonferroni t tests could not identify any significant differences between pairs of scenarios within an event.

Table L-55

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Acquisition and Engagement Cathits

	Scenario		
Event	A	B	C
A	1.94 (.07)	1.94 (.07)	2.00 (.00)
B	2.50 (.15)	2.51 (.16)	2.55 (.26)
C	2.43 (.24)	2.09 (.35)	3.00 (.00)
D	1.00 (.00)	1.00 (.00)	1.00 (.00)
E	7.97 (.77)	7.78 (.37)	7.97 (.57)
F	2.10 (.64)	2.06 (.15)	2.40 (.26)
G	2.77 (.22)	3.00 (.00)	2.84 (.12)
H	3.00 (.00)	2.87 (.16)	2.97 (.06)
I	1.81 (.05)	1.78 (.17)	1.76 (.11)
J	1.00 (.00)	1.00 (.00)	1.00 (.00)

Note. $n = 4$. Bonferroni t tests could not identify any significant differences between pairs of scenarios within an event.

Table L-56

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Acquisition and Engagement Killtime

	Scenario		
Event	A	B	C
A	68.44 (17.86)	34.81 (7.28)	15.56 (5.65)
B	23.10 (7.39)	28.79 (8.61)	19.25 (4.97)
C	33.15 (9.54)	43.91 (16.80)	36.00 (.00)
D	.00 (.00)	11.23 (13.59)	.00 (.00)
E	352.66 (64.79)	228.16 (48.07)	396.78 (122.84)
F	43.17 (47.07)	19.32 (5.78)	20.59 (5.69)
G	56.77 (8.75)	68.63 (28.06)	95.59 (28.48)
H	25.25 (4.98)	68.27 (26.76)	80.31 (11.03)
I	29.63 (15.35)	38.10 (49.09)	18.28 (5.16)
J	.00 (.00)	.00 (.00)	4.81 (9.63)

Note. *n* = 4. Bonferroni *t* tests could not identify any significant differences between pairs of scenarios within an event.

Table L-57

Summary of Bonferroni t tests for Scenario by Event Interaction on Lethality: Acquisition and Engagement Performance Measures

			Gunnery		Cathits		Killtime	
Event	Comparison	df	t	(p)	t	(p)	t	(p)
	Scenario							
A	A vs B	3	2.18	(.117)	.00	(1.000)	4.25	(.024)
	A vs C	3	-1.64	(.200)	-1.73	(.182)	7.07	(.006)
	B vs C	3	-8.40	(.004)	-1.73	(.182)	3.94	(.029)
B	A vs B	3	1.75	(.178)	-.03	(.979)	-.79	(.488)
	A vs C	3	-1.72	(.184)	-.25	(.820)	.83	(.466)
	B vs C	3	-4.04	(.027)	-.35	(.747)	2.55	(.084)
C	A vs B	3	-.45	(.682)	1.49	(.234)	-1.06	(.367)
	A vs C	3	--	---	--	---	--	---
	B vs C	3	--	---	--	---	--	---
D	A vs B	3	-2.71	(.113)	--	---	-1.87	(.203)
	A vs C	3	-3.15	(.088)	--	---	--	---
	B vs C	3	3.44	(.041)	--	---	1.65	(.197)
E	A vs B	3	-3.12	(.053)	.88	(.444)	2.21	(.114)
	A vs C	3	.05	(.960)	.00	(1.000)	-.48	(.663)
	B vs C	3	2.22	(.113)	-.67	(.553)	-4.14	(.026)
F	A vs B	3	1.46	(.241)	.12	(.910)	1.00	(.393)
	A vs C	3	-.29	(.788)	-.72	(.521)	.94	(.416)
	B vs C	3	-1.97	(.144)	-2.44	(.092)	-.27	(.805)
G	A vs B	3	-1.22	(.310)	-2.11	(.125)	-.81	(.475)
	A vs C	3	.93	(.423)	-1.19	(.320)	-2.60	(.081)
	B vs C	3	2.40	(.096)	2.61	(.080)	-1.09	(.355)
H	A vs B	3	3.12	(.052)	1.72	(.183)	-2.72	(.072)
	A vs C	3	3.37	(.043)	1.00	(.391)	-7.73	(.004)
	B vs C	3	1.54	(.220)	-1.04	(.376)	-.93	(.422)
I	A vs B	3	-1.79	(.171)	.40	(.714)	-.29	(.789)
	A vs C	3	-3.01	(.057)	.86	(.454)	1.90	(.154)
	B vs C	3	-.35	(.753)	.12	(.909)	.77	(.498)
J	A vs B	3	-.87	(.448)	--	---	--	---
	A vs C	3	1.22	(.308)	--	---	-1.00	(.391)
	B vs C	3	1.87	(.158)	--	---	-1.00	(.391)

Note. * $p < .003$ to maintain overall error rate for each set of comparisons at .10 level of significance. -- indicates t test could not be computed due to no variance in both means. No significant differences were found between each pair of scenarios within an event.

Table L-58

Means and Standard Deviations (in parentheses) for Configuration by Mode on Lethality: Acquisition and Engagement Cathits

	Configuration		
Mode	1	3	4
Auto	2.94 (.10)	2.44 (.14)	2.26 (.23)
Semi	2.94 (.03)	2.34 (.09)	2.38 (.20)

Note. n = 4. One-tailed Bonferroni t tests could not identify any significant differences between each pair of configurations within a mode.

Table L-59

Summary of Bonferroni t tests for for Configuration by Mode on Lethality: Acquisition and Engagement Cathits

Mode	Comparison	df	t (p)
	Configuration		
Auto	1 vs 3	3	8.14 (.998)
	1 vs 4	3	7.26 (.998)
	3 vs 4	3	2.62 (.962)
Semi	1 vs 3	3	17.61(1.000)
	1 vs 4	3	5.07 (.993)
	3 vs 4	3	-.31 (.040)

Note. * p < .033 to maintain overall error rate for the set of comparisons at .10 level of significance. No significant differences were found between each pair of configurations within a mode.

Table L-60

Means and Standard Deviations (in parentheses) for Main Effects on Lethality: Acquisition and Engagement Ranges

Measure	Block 1	Block 2
Ranges	1955.29 (187.80)	2118.39 (110.49)
# trials	410	419

Measure	Configuration B	1	3	4
Ranges	1937.98 (102.77)	1959.87 (81.14)	2084.93 (205.83)	2186.39 (381.02)
# trials	212	219	202	196

Measure	Scenario A	B	C
Ranges	2074.90 (83.66)	2028.51 (134.17)	2016.64 (242.15)
# trials	263	288	278

Measure	Event A	B	C	D	E
Ranges	1454.53 (860.73)	505.06 (428.54)	2414.25 (824.43)	2168.79 (2026.70)	2590.96 (671.04)
# of trials	96	92	61	62	96
Measure	**F**	**G**	**H**	**I**	**J**
Ranges	1645.52 (676.89)	2654.84 (491.03)	2561.29 (439.75)	2169.41 (1491.44)	2317.77 (664.91)
# of trials	68	91	95	78	90

Measure	Mode Auto	Semi
Ranges	2021.70 (142.51)	2123.40 (222.39)
# trials	307	310

Note. B = Baseline (under Configuration). $\underline{n}$ = 4. $\underline{N}$ = 960 for total number of trials except for Mode in which $\underline{N}$ = 720. Fourteen percent missing data for ranges.

Table L-61

Summary of Univariate F Tests on Lethality: Miscellaneous Performance Measures

Effect	df	Kill2hit F	Kill2hit (p)	Kill2kil F	Kill2kil (p)
Main Effect					
Block (B)	1,3	1.62	(.296)	.62	(.490)
Config (C)	3,9	16.42	(.001)*	22.83	(.000)*
Scene (S)	2,6	.22	(.810)	7.02	(.027)
Event (E)	7,21	85.54	(.000)*	138.88	(.000)*
Two-way Interactions					
B x C	3,9	.72	(.566)	1.02	(.429)
B x S	2,6	1.36	(.325)	.74	(.518)
B x E	7,21	1.76	(.148)	.68	(.690)
C x S	6,18	1.84	(.147)	1.44	(.255)
C x E	21,63	4.51	(.000)*	8.78	(.000)*
S x E	14,42	4.88	(.000)*	4.49	(.000)*
Three-way Interactions					
B x C x S	6,18	2.79	(.043)	.97	(.474)
B x C x E		Not able to test			
B x S x E		Not able to test			
C x S x E		Not able to test			
Mode Effects					
Mode (M)	1,3	.42	(.562)	1.27	(.341)
C x M	2,6	.74	(.515)	.01	(.992)
C x M x E	12,36	.76	(.703)	1.09	(.394)

Note. * $p < .025$ to maintain family-wise error rate for this group of dependent variables at .10 level of significance.

Table L-62

Means and Standard Deviations (in parentheses) for Configuration on Lethality: Miscellaneous Performance Measures

Measure	Configuration B	Configuration 1	Configuration 3	Configuration 4
Kill2hit	1.17a (.24)	1.83b (.25)	1.71b (.24)	1.45b (.25)
Kill2kil	1.22a (.26)	1.99b (.15)	1.79b (.25)	1.61b (.18)

Note. B = Baseline. $n = 4$. Means in the same row with different letters differ, $p < .033$, one-tailed Bonferroni t test.

Table L-63

Summary of Bonferroni t tests for Configuration on Survivability: Missile Performance Measures

		Kill2hit		Kill2kil	
Comparison	df	t	(p)	t	(p)
Configuration					
Base vs 1	3	-5.16	(.007)*	-7.33	(.003)*
Base vs 3	3	-8.67	(.002)*	-5.82	(.005)*
Base vs 4	3	-6.07	(.005)*	-5.19	(.007)*
1 vs 3	3	1.19	(.840)	2.55	(.958)
1 vs 4	3	2.59	(.081)	4.53	(.990)
3 vs 4	3	2.57	(.959)	1.39	(.870)

Note. * $p < .033$ to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-64

Means and Standard Deviations (in parentheses) for Event on Lethality: Miscellaneous Performance Measures

	Event			
Measure	A	B	C	D
Kill2hit	1.55	1.57	.84	.57
	(.25)	(.43)	(.22)	(.17)
Kill2kil	1.60	1.90	.84	.57
	(.19)	(.37)	(.22)	(.17)

	Event			
Measure	E	F	I	J
Kill2hit	5.02	.93	.97	.84
	(.81)	(.20)	(.18)	(.04)
Kill2hit	5.48	.98	1.00	.85
	(.67)	(.22)	(.18)	(.04)

Note. n = 4. See Table L-65 for significant differences between each pair of events.

Table L-65

Summary of Bonferroni t tests for Event on Lethality: Miscellaneous Performance Measures

Comparison	df	Kill2hit t	(p)	Kill2kil t	(p)
Event					
A vs B	3	-.09	(.933)	-1.48	(.237)
A vs C	3	5.40	(.012)	6.42	(.008)
A vs D	3	4.69	(.018)	5.77	(.010)
A vs E	3	-8.84	(.003)*	-12.21	(.001)*
A vs F	3	4.09	(.026)	4.21	(.025)
A vs I	3	3.05	(.055)	3.77	(.033)
A vs J	3	5.27	(.013)	6.55	(.007)
B vs C	3	5.92	(.010)	11.99	(.001)*
B vs D	3	3.91	(.030)	5.94	(.010)
B vs E	3	-16.82	(.000)*	-16.33	(.001)*
B vs F	3	5.12	(.014)	11.75	(.001)*
B vs I	3	3.15	(.051)	6.10	(.009)
B vs J	3	3.67	(.035)	5.82	(.010)
C vs D	3	1.66	(.195)	1.66	(.195)
C vs E	3	-12.83	(.001)*	-17.11	(.000)*
C vs F	3	-2.99	(.058)	-3.23	(.048)
C vs I	3	-1.23	(.306)	-1.72	(.184)
C vs J	3	-.03	(.980)	-.14	(.895)
D vs E	3	-10.07	(.002)*	-12.80	(.001)*
D vs F	3	-2.57	(.083)	-2.77	(.070)
D vs I	3	-5.15	(.014)	-4.76	(.018)
D vs J	3	-3.37	(.043)	-4.14	(.026)
E vs F	3	12.54	(.001)*	16.79	(.000)*
E vs I	3	10.46	(.002)*	13.18	(.001)*
E vs J	3	10.71	(.002)*	13.73	(.001)*
F vs I	3	-.42	(.704)	-.30	(.782)
F vs J	3	1.11	(.346)	1.18	(.323)
H vs J	3	1.80	(.169)	2.03	(.135)

Note. * $p < .004$ to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-66

Means and Standard Deviations (in parentheses) for Configuration by Event Interaction on Lethality: Miscellaneous Kill2hit

Event	B	1	3	4
	Configuration			
A	1.21a (.28)	1.54 (.34)	1.75 (.29)	1.77b (.34)
B	1.54 (.44)	1.71 (.52)	1.88 (.48)	1.17 (.49)
C	.79 (.50)	.92 (.10)	.88 (.34)	.79 (.28)
D	.46a (.21)	.75b (.29)	.58 (.10)	.50 (.24)
E	3.21a (1.30)	5.96 (1.42)	6.08b (.63)	4.83 (1.34)
F	.92 (.42)	1.46 (.25)	.67 (.43)	.69 (.22)
I	.58 (.35)	1.42 (.22)	.88 (.32)	1.00 (.27)
J	.63 (.16)	.88 (.08)	1.00 (.00)	.88 (.08)

Note. B = Baseline (in Configuration). n = 4. See Table L-67 for significant differences between each pair of configurations.

Table L-67

Means and Standard Deviations (in parentheses) for Configuration by Event Interaction on Lethality: Miscellaneous Kill2kil

Event	B	1	3	4
	Configuration			
A	1.21a (.28)	1.54 (.34)	1.79 (.25)	1.88b (.16)
B	1.88 (.53)	1.88 (.52)	2.21 (.34)	1.63 (.34)
C	.79 (.50)	.92 (.10)	.88 (.34)	.79 (.28)
D	.46a (.21)	.75b (.29)	.58 (.10)	.50 (.24)
E	3.25 (1.35)	7.00 (.71)	6.25 (.83)	5.41 (.93)
F	.96 (.50)	1.50 (.24)	.71 (.46)	.73 (.30)
I	.63a (.34)	1.46 (.16)	.92 (.40)	1.00b (.27)
J	.63 (.16)	.88 (.08)	1.00 (.00)	.91 (.10)

Note. B = Baseline (in Configuration). $\underline{n}$ = 4. See Table L-68 for significant differences between each pair of configurations.

Table L-68

Summary of Bonferroni t tests for Configuration by Event on Lethality: Miscellaneous Performance Measures

			Kill2hit		Kill2kil	
Event	Comparison	df	t	(p)	t	(p)
	Configuration					
A	Base vs 1	3	-2.82	(.034)	-2.82	(.034)
	Base vs 3	3	-3.84	(.016)	-3.67	(.017)
	Base vs 4	3	-7.20	(.003)*	-9.61	(.001)*
	1 vs 3	3	-.88	(.211)	-1.06	(.185)
	1 vs 4	3	-2.49	(.045)	-2.90	(.031)
	3 vs 4	3	.20	(.574)	-.57	(.305)
B	Base vs 1	3	-.64	(.285)	-.01	(.497)
	Base vs 3	3	-2.43	(.047)	-3.52	(.020)
	Base vs 4	3	2.04	(.933)	2.33	(.949)
	1 vs 3	3	-.73	(.259)	-1.26	(.149)
	1 vs 4	3	3.45	(.978)	1.14	(.832)
	3 vs 4	3	8.98	(.999)	11.92	(1.000)
C	Base vs 1	3	-.56	(.308)	-.56	(.308)
	Base vs 3	3	-.49	(.329)	-.49	(.329)
	Base vs 4	3	.00	(.500)	.00	(.500)
	1 vs 3	3	.30	(.609)	.30	(.609)
	1 vs 4	3	.86	(.773)	.86	(.773)
	3 vs 4	3	.43	(.651)	.43	(.651)
D	Base vs 1	3	-6.76	(.004)*	-6.76	(.004)*
	Base vs 3	3	-1.00	(.120)	-1.00	(.120)
	Base vs 4	3	-.48	(.334)	-.48	(.334)
	1 vs 3	3	.97	(.798)	.97	(.798)
	1 vs 4	3	2.33	(.949)	2.33	(.949)
	3 vs 4	3	.81	(.762)	.81	(.762)
E	Base vs 1	3	-2.47	(.045)	-4.80	(.008)
	Base vs 3	3	-5.13	(.007)*	-4.12	(.013)
	Base vs 4	3	-4.65	(.010)	-5.73	(.995)
	1 vs 3	3	-.20	(.427)	2.14	(.939)
	1 vs 4	3	1.19	(.841)	3.07	(.973)
	3 vs 4	3	2.16	(.990)	1.31	(.860)
F	Base vs 1	3	-2.49	(.046)	-2.19	(.059)
	Base vs 3	3	.78	(.755)	.78	(.755)
	Base vs 4	3	.72	(.740)	.59	(.702)
	1 vs 3	3	5.63	(.995)	4.32	(.012)
	1 vs 4	3	5.38	(.994)	4.68	(.991)
	3 vs 4	3	-.15	(.447)	-.13	(.454)
I	Base vs 1	3	-4.97	(.008)	-4.62	(.010)
	Base vs 3	3	-1.06	(.184)	-1.06	(.184)
	Base vs 4	3	1.19	(.841)	-8.76	(.002)*
	1 vs 3	3	2.96	(.970)	2.60	(.960)
	1 vs 4	3	4.42	(.990)	2.91	(.969)
	3 vs 4	3	2.43	(.953)	-.32	(.616)
J	Base vs 1	3	-2.30	(.053)	-2.30	(.948)
	Base vs 3	3	-4.73	(.009)	-4.73	(.009)
	Base vs 4	3	.01	(.504)	-2.77	(.035)
	1 vs 3	3	-3.00	(.029)	-3.00	(.029)
	1 vs 4	3	1.27	(.852)	-1.00	(.120)
	3 vs 4	3	1.82	(.917)	1.73	(.909)

Note. * $p < .004$ to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-69

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Miscellaneous Kill2hit

	Scenario		
Event	A	B	C
A	1.69 (.07)	1.66 (.39)	1.31 (.41)
B	1.63 (.42)	1.38 (.44)	1.72 (.50)
C	1.00a (.14)	1.44 (.43)	.09b (.19)
D	.25 (.27)	.59 (.21)	.88 (.10)
E	5.31 (1.19)	4.72 (1.12)	5.03 (.30)
F	.75 (.35)	.94 (.24)	1.11 (.36)
I	.81 (.16)	1.13 (.18)	.97 (.43)
J	.84 (.16)	.72 (.16)	.97 (.06)

Note. n = 4. Means in the same row with different letters differ, p < .004, Bonferroni t test.

Table L-70

Means and Standard Deviations (in parentheses) for Scenario by Event Interaction on Lethality: Miscellaneous Kill2kil

	Scenario		
Event	A	B	C
A	1.72 (.06)	1.66 (.39)	1.44 (.30)
B	1.94 (.33)	1.84 (.33)	1.91 (.49)
C	1.00a (.14)	1.44 (.43)	.09b (.19)
D	.25 (.27)	.59 (.21)	.88 (.10)
E	5.31 (1.19)	5.78 (.68)	5.34 (.19)
F	.75 (.35)	1.03 (.26)	1.14 (.39)
I	.91 (.24)	1.13 (.18)	.97 (.43)
J	.88 (.10)	.72 (.16)	.97 (.06)

Note. n = 4. Means in the same row with different letters differ, p < .004, Bonferroni t test.

Table L-71

Summary of Bonferroni t tests for Scenario by Event on Lethality: Miscellaneous Performance Measures

			Kill2hit		Kill2kil	
Event	Comparison	df	t	(p)	t	(p)
	Scenario					
A	A vs B	3	.16	(.882)	.28	(.795)
	A vs C	3	1.68	(.191)	1.56	(.216)
	B vs C	3	2.66	(.076)	1.59	(.210)
B	A vs B	3	1.35	(.271)	1.55	(.219)
	A vs C	3	-.59	(.595)	.25	(.819)
	B vs C	3	-4.29	(.023)	-.56	(.617)
C	A vs B	3	-2.78	(.069)	-2.78	(.069)
	A vs C	3	11.45	(.001)*	11.45	(.001)*
	B vs C	3	6.52	(.007)	6.52	(.007)
D	A vs B	3	-5.74	(.010)	-5.74	(.010)
	A vs C	3	-4.66	(.019)	-4.66	(.019)
	B vs C	3	-3.00	(.058)	-3.00	(.058)
E	A vs B	3	7.42	(.005)	-1.63	(.202)
	A vs C	3	.49	(.657)	-.06	(.957)
	B vs C	3	-.58	(.602)	1.56	(.216)
F	A vs B	3	-.90	(.434)	-1.45	(.242)
	A vs C	3	-1.19	(.321)	-1.30	(.283)
	B vs C	3	-1.85	(.162)	-1.00	(.392)
I	A vs B	3	-3.94	(.025)	-2.36	(.100)
	A vs C	3	-.84	(.463)	-.28	(.797)
	B vs C	3	.60	(.589)	.60	(.589)
J	A vs B	3	.94	(.417)	1.45	(.243)
	A vs C	3	-1.22	(.308)	-1.20	(.317)
	B vs C	3	-2.83	(.066)	-2.83	(.066)

Note. * $p < .004$ to maintain overall error rate for each set of comparisons at .10 level of significance.

Table L-72

Summary of Univariate F Tests on Platoon Leader Workload Ratings

Effect	df	F (p)
Task (T)	2,6	7.65 (.022)*
Config (C)	3,9	.27 (.846)
T x C	6,18	1.60 (.204)
VIDS Only		
Mode (M)	1,3	.02 (.889)
C x M	2,6	.90 (.455)
T x C x M	4,12	1.66 (.223)

Note. * $p < .05$ to maintain family-wise error rate at .10 level of significance.

Table L-73

Means and Standard Deviations (in parentheses) for Task on Platoon Keader Workload Ratings

CSS	DPM	DPF
7.79	8.90	8.00
(1.98)	(2.30)	(2.03)

Note. $n = 4$. CSS = coordiante sector searches; DPM = direct platoon maneuver; DPF = direct platoon fires. Bonferroni t tests could not identify any significant differences between each pair of tasks.

Table L-74

Summary of Bonferroni t tests for Task on Platoon Leader Workload Ratings

Comparison	df	t (p)
Task		
CSS vs DPM	3	-3.46 (.041)
CSS vs DPF	3	-1.06 (.368)
DPM vs DPF	3	2.50 (.088)

Note. CSS = coordiante sector searches; DPM = direct platoon maneuver; DPF = direct platoon fires. * $p < .033$ to maintain overall error rate the set of comparisons at .10 level of significance. No significant differences were found between each pair of tasks.

Table L-75

Means and Standard Deviations (in parentheses) for Task by Configuration Interaction on Platoon Leader Workload Ratings

	Configuration			
Task	B	1	3	4
CSS	7.62 (1.48)	7.75 (2.12)	8.25 (2.17)	7.54 (2.86)
DPM	9.58 (1.12)	7.92 (2.26)	8.77 (3.01)	9.33 (3.47)
DPF	8.29 (1.33)	7.73 (2.03)	7.92 (2.73)	8.06 (2.88)

Note. B = Baseline. CSS = coordiante sector searches; DPM = direct platoon maneuver; DPF = direct platoon fires. n = 4.

Table L-76

Summary of Univariate F Tests on Tank Commander Workload Ratings

Effect	df	F	(p)
Task (T)	4,60	4.59	(.003)*
Config (C)	3,45	8.08	(.000)*
T x C	12,180	2.39	(.007)*
VIDS Only			
Mode (M)	1,15	.13	(.726)
C x M	2,30	1.79	(.185)
T x C x M	8,120	.93	(.497)

Note. * p < .05 to maintain family-wise error rate at .10 level of significance.

Table L-77

Means and Standard Deviations (in parentheses) for Task on Tank Commander Workload Ratings

AT	ET	EA	CR	SR
9.18a (1.65)	8.89 (2.23)	8.73a (1.96)	7.68b (1.95)	7.69b (1.97)

Note. n = 16. AT = acquire targets; ET = engage targets; EA = evade ATGMs; CR = prepare and send contact reports; SR = prepare and send spot reports. Means in the same row with different letters differ, p < .01, Bonferroni t test.

Table L-78

Summary of Bonferroni *t* tests for Task on Tank Commander Workload Ratings

Comparison	*df*	*t* (*p*)
Task		
AT vs ET	15	1.12 (.279)
AT vs EA	15	.93 (.369)
AT vs CR	15	3.14 (.007)*
AT vs SR	15	3.48 (.003)*
ET vs EA	15	.26 (.801)
ET vs CR	15	1.86 (.082)
ET vs SR	15	2.05 (.058)
EA vs CR	15	2.96 (.010)*
EA vs SR	15	3.44 (.004)*
CR vs SR	15	-.64 (.955)

Note. AT = acquire targets; ET = engage targets; EA = evade ATGMs; CR = prepare and send contact reports; SR = prepare and send spot reports. * $p < .01$ to maintain overall error rate the set of comparisons at .10 level of significance.

Table L-79

Means and Standard Deviations (in parentheses) for Configuration on Tank Commander Workload Ratings

Configuration			
B	1	3	4
8.00 (1.12)	7.62 (1.88)	8.72 (2.12)	9.38 (2.06)

Note. B = Baseline. $n = 16$. See Table L-79 for significant differences between each pair of configurations.

Table L-80

Summary of Bonferroni *t* tests for Configuration on Tank Commander Workload Ratings

Comparison	*df*	*t* (*p*)
Configuration		
Base vs 1	3	.91 (.379)
Base vs 3	3	-1.63 (.123)
Base vs 4	3	-2.87 (.012)*
1 vs 3	3	-5.12 (.000)*
1 vs 4	3	-4.66 (.000)*
3 vs 4	3	-1.97 (.068)

Note. * $p < .017$ to maintain overall error rate for the set of comparisons at .10 level of significance.

Table L-81

Means and Standard Deviations (in parentheses) for Task by Configuration Interaction on Tank Commander Workload Ratings

	Configuration			
Task	B	1	3	4
AT	8.67 (1.47)	8.06a (1.92)	9.44b (2.23)	10.54b (2.52)
ET	8.05 (2.68)	8.10a (2.26)	9.38 (2.70)	10.03b (2.53)
EA	9.10 (1.76)	7.80 (2.47)	8.70 (2.48)	9.31 (2.47)
CR	7.18 (1.21)	6.95a (2.21)	8.10 (2.52)	8.48b (2.72)
SR	7.01 (1.37)	7.18a (2.25)	8.00 (2.68)	8.55b (2.58)

Note. B = Baseline. AT = acquire targets; ET = engage targets; EA = evade ATGMs; CR = prepare and send contact reports; SR = prepare and send spot reports. _n_ = 16. Means in the same row with different letters differ, _p_ < .003, Bonferroni _t_ test.

Table L-82

Summary of Bonferroni _t_ tests for Task by Configuration Interaction on Tank Commander Workload Ratings

Task	Comparison	_df_	_t_	(_p_)
	Configuration			
AT	Base vs 1	15	1.39	(.184)
	Base vs 3	15	-1.63	(.124)
	Base vs 4	15	-3.40	(.004)
	1 vs 3	15	-3.64	(.002)*
	1 vs 4	15	-4.01	(.001)*
	3 vs 4	15	-1.89	(.079)
ET	Base vs 1	15	-.10	(.919)
	Base vs 3	15	-2.52	(.023)
	Base vs 4	15	-3.24	(.006)
	1 vs 3	15	-3.89	(.012)
	1 vs 4	15	-3.71	(.002)*
	3 vs 4	15	-1.29	(.216)
EA	Base vs 1	15	2.39	(.031)
	Base vs 3	15	.60	(.555)
	Base vs 4	15	-.32	(.750)
	1 vs 3	15	-2.23	(.042)
	1 vs 4	15	-3.22	(.006)
	3 vs 4	15	-2.07	(.056)
CR	Base vs 1	15	.46	(.651)
	Base vs 3	15	-1.84	(.086)
	Base vs 4	15	-2.32	(.035)
	1 vs 3	15	-2.93	(.010)
	1 vs 4	15	-3.81	(.002)*
	3 vs 4	15	-1.32	(.206)

(table continues)

Task	Comparison	df	t	(p)
	Configuration			
SR	Base vs 1	15	-.39	(.704)
	Base vs 3	15	-1.79	(.093)
	Base vs 4	15	-2.84	(.012)
	1 vs 3	15	-1.89	(.079)
	1 vs 4	15	-4.82	(.000)*
	3 vs 4	15	-1.10	(.288)

Note. AT = acquire targets; ET = engage targets; EA = evade ATGMs; CR = prepare and send contact reports; SR = prepare and send spot reports. * $p < .003$ to maintain overall error rate for the set of comparisons at .10 level of significance.

Table L-83

Summary of Univariate F Tests on Tank Commander Workload Subtask Ratings

Task	Effect	df	F	(p)
AT	Subtask (S)	5,75	8.86	(.000)*
	S x Config	15,225	2.69	(.001)*
ET	Subtask (S)	5,75	7.38	(.000)*
	S x Config	15,225	3.06	(.000)*
EA	Subtask (S)	5,75	6.91	(.000)*
	S x Config	15,225	2.24	(.006)*
CR	Subtask (S)	5,75	5.90	(.000)*
	S x Config	15,225	2.59	(.000)*
SR	Subtask (S)	5,75	5.74	(.000)*
	S x Config	15,225	2.77	(.001)*

Note. AT = acquire targets; ET = engage targets; EA = evade ATGMs; CR = prepare and send contact reports; SR = prepare and send spot reports. * $p < .02$ to maintain family-wise error rate at .10 level of significance.

Table L-84

Means and Standard Deviations (in parentheses) for Subtask on Acquire Targets

MD	PD	TD	P	E	F
9.88	7.06	9.79	6.71	10.39	11.23
(3.64)	(2.51)	(3.06)	(2.14)	(2.70)	(2.56)

Note. $n = 16$. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration. See Table L-85 for significant differences between each pair of subtasks.

Table L-85

Summary of Bonferroni t tests for Subtask on Acquire Targets

Comparison	df	t (p)
Subtask		
MD vs PD	15	2.62 (.019)
MD vs TD	15	.14 (.890)
MD vs P	15	3.03 (.008)
MD vs E	15	-.46 (.653)
MD vs F	15	-1.15 (.266)
PD vs TD	15	-3.43 (.004)
PD vs P	15	.82 (.425)
PD vs E	15	-3.80 (.002)
PD vs F	15	-6.69 (.000)*
TD vs P	15	3.44 (.004)
TD vs E	15	-.67 (.514)
TD vs F	15	-1.47 (.162)
P vs E	15	-4.34 (.001)*
P vs F	15	-6.41 (.000)*
E vs F	15	-1.08 (.296)

Note. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration.* $p < .001$ to maintain overall error rate the set of comparisons at .02 level of significance.

Table L-86

Means and Standard Deviations (in parentheses) for Subtask by Configuration Interaction on Acquire Targets

	Configuration			
Subtask	B	1	3	4
Mental	9.54 (3.24)	9.36 (4.02)	9.76 (4.05)	10.85 (4.70)
Physical	6.14 (2.43)	6.46 (2.92)	7.21 (3.27)	8.41 (3.99)
Time	10.05 (2.93)	9.15 (3.34)	9.62 (3.71)	10.34 (4.01)
Performance	6.39 (2.55)	5.30a (2.76)	6.71 (2.85)	8.42b (2.76)
Effort	9.76 (2.13)	9.55 (3.22)	10.98 (2.81)	11.28 (4.01)
Frustration	10.12 (2.83)	8.53a (3.05)	12.37 (4.95)	13.91b (3.75)

Note. B = Baseline. $n = 16$. Means in the same row with different letters differ, $p < .001$, Bonferroni t test.

Table L-87

Summary of Bonferroni t tests for Subtask by Configuration Interaction on Acquire Targets

Subtask	Comparison	df	t	(p)
	Configuration			
Mental	Base vs 1	15	.30	(.767)
	Base vs 3	15	-.32	(.754)
	Base vs 4	15	-1.86	(.082)
	1 vs 3	15	-.66	(.519)
	1 vs 4	15	-1.78	(.095)
	3 vs 4	15	-1.39	(.185)
Physical	Base vs 1	15	-.37	(.714)
	Base vs 3	15	-1.30	(.214)
	Base vs 4	15	-2.51	(.024)
	1 vs 3	15	-1.93	(.072)
	1 vs 4	15	-2.05	(.058)
	3 vs 4	15	-1.44	(.171)
Time	Base vs 1	15	1.81	(.090)
	Base vs 3	15	.76	(.461)
	Base vs 4	15	-.42	(.678)
	1 vs 3	15	-.81	(.428)
	1 vs 4	15	-1.40	(.182)
	3 vs 4	15	-.76	(.461)
Performance	Base vs 1	15	1.92	(.074)
	Base vs 3	15	-.56	(.582)
	Base vs 4	15	-2.35	(.033)
	1 vs 3	15	-2.60	(.020)
	1 vs 4	15	-4.00	(.001)*
	3 vs 4	15	-2.27	(.039)
Effort	Base vs 1	15	.33	(.745)
	Base vs 3	15	-2.30	(.036)
	Base vs 4	15	-2.04	(.060)
	1 vs 3	15	-2.43	(.028)
	1 vs 4	15	-2.55	(.022)
	3 vs 4	15	-.45	(.657)
Frustration	Base vs 1	15	1.79	(.094)
	Base vs 3	15	-1.66	(.117)
	Base vs 4	15	-3.56	(.003)
	1 vs 3	15	-3.26	(.005)
	1 vs 4	15	-5.73	(.000)*
	3 vs 4	15	-1.30	(.212)

Note. * $p < .001$ to maintain overall error rate for the set of comparisons at .02 level of significance.

Table L-88

Means and Standard Deviations (in parentheses) for Subtask on Engage Targets

MD	PD	TD	P	E	F
9.11 (3.57)	6.82 (2.61)	9.59 (3.60)	6.57 (2.91)	10.38 (3.88)	10.88 (3.04)

Note. n = 16. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration. See Table L-89 for significant differences between each pair of subtasks.

Table L-89

Summary of Bonferroni t tests for Subtask on Engage Targets

Comparison	df	t (p)
Subtask		
MD vs PD	15	2.44 (.028)
MD vs TD	15	-1.26 (.228)
MD vs P	15	2.56 (.022)
MD vs E	15	-1.16 (.262)
MD vs F	15	-1.65 (.119)
PD vs TD	15	-2.98 (.009)
PD vs P	15	.48 (.635)
PD vs E	15	-2.99 (.009)
PD vs F	15	-4.96 (.000)*
TD vs P	15	3.25 (.005)
TD vs E	15	-.84 (.413)
TD vs F	15	-1.30 (.212)
P vs E	15	-3.49 (.003)
P vs F	15	-5.38 (.000)*
E vs F	15	-.46 (.655)

Note. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration. * p < .001 to maintain overall error rate the set of comparisons at .02 level of significance.

Table L-90

Means and Standard Deviations (in parentheses) for Subtask by Configuration Interaction on Engage Targets

	Configuration			
Subtask	B	1	3	4
Mental	8.53 (3.47)	8.96 (4.08)	9.20 (4.16)	9.76 (3.96)
Physical	5.90 (2.33)	6.44 (3.05)	7.20 (3.37)	7.76 (3.38)
Time	9.19 (4.39)	8.97 (3.25)	10.00 (4.65)	10.19 (3.13)
Performance	6.32 (3.62)	6.05 (3.04)	6.48 (3.50)	7.44 (3.44)
Effort	9.76 (3.98)	9.33 (4.26)	10.76 (4.62)	11.66 (4.03)
Frustration	8.61a (3.67)	8.85 (3.29)	12.66 (5.07)	13.38b (4.45)

Note. B = Baseline. *n* = 16. Means in the same row with different letters differ, *p* < .001, Bonferroni *t* test.

Table L-91

Summary of Bonferroni *t* tests for Subtask by Configuration Interaction on Engage Targets

Subtask	Comparison	*df*	*t* (*p*)
	Configuration		
Mental	Base vs 1	15	-.85 (.409)
	Base vs 3	15	-.91 (.378)
	Base vs 4	15	-1.88 (.079)
	1 vs 3	15	-.41 (.685)
	1 vs 4	15	-1.23 (.239)
	3 vs 4	15	-.67 (.516)
Physical	Base vs 1	15	-.86 (.404)
	Base vs 3	15	-1.96 (.069)
	Base vs 4	15	-2.46 (.026)
	1 vs 3	15	-2.46 (.027)
	1 vs 4	15	-1.89 (.079)
	3 vs 4	15	-.75 (.464)
Time	Base vs 1	15	.38 (.712)
	Base vs 3	15	-1.45 (.168)
	Base vs 4	15	-1.61 (.129)
	1 vs 3	15	-1.79 (.094)
	1 vs 4	15	-2.06 (.057)
	3 vs 4	15	-.24 (.816)
Performance	Base vs 1	15	.32 (.757)
	Base vs 3	15	-.23 (.821)
	Base vs 4	15	-1.33 (.205)
	1 vs 3	15	-.67 (.513)
	1 vs 4	15	-2.08 (.055)
	3 vs 4	15	-1.73 (.104)

(*table continues*)

Subtask	Comparison	df	t	(p)
	Configuration			
Effort	Base vs 1	15	.65	(.526)
	Base vs 3	15	-1.18	(.258)
	Base vs 4	15	-2.61	(.020)
	1 vs 3	15	-2.35	(.033)
	1 vs 4	15	-3.58	(.003)
	3 vs 4	15	-1.56	(.140)
Frustration	Base vs 1	15	.22	(.832)
	Base vs 3	15	-2.93	(.010)
	Base vs 4	15	-3.46	(.003)
	1 vs 3	15	-3.37	(.004)
	1 vs 4	15	-4.80	(.000)*
	3 vs 4	15	-.71	(.491)

Note. * $p < .001$ to maintain overall error rate for the set of comparisons at .02 level of significance.

Table L-92

Means and Standard Deviations (in parentheses) for Subtask on Evade ATGMs

MD	PD	TD	P	E	F
9.50 (3.03)	6.85 (2.44)	8.98 (2.96)	7.05 (2.87)	9.76 (2.99)	10.21 (2.43)

Note. n = 16. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration. See Table L-93 for significant differences between each pair of subtasks.

Table L-93

Summary of Bonferroni t tests for Subtask on Evade ATGMs

Comparison	df	t	(p)
Subtask			
MD vs PD	15	3.32	(.005)
MD vs TD	15	1.19	(.252)
MD vs P	15	3.23	(.006)
MD vs E	15	-.24	(.812)
MD vs F	15	-.76	(.458)
PD vs TD	15	-3.07	(.008)
PD vs P	15	-.53	(.601)
PD vs E	15	-3.31	(.005)
PD vs F	15	-8.06	(.000)*
TD vs P	15	2.96	(.010)
TD vs E	15	-.86	(.405)
TD vs F	15	-1.47	(.163)
P vs E	15	-2.73	(.015)
P vs F	15	-5.79	(.000)*
E vs F	15	-.57	(.580)

Note. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration.* $p < .001$ to maintain overall error rate the set of comparisons at .02 level of significance.

Table L-94

Means and Standard Deviations (in parentheses) for Subtask by Configuration Interaction on Evade ATGMs

Subtask	Configuration B	1	3	4
Mental	9.69 (2.55)	9.20 (3.98)	9.55 (3.94)	9.54 (3.25)
Physical	6.24 (2.65)	6.53 (2.93)	7.27 (2.48)	7.36 (2.84)
Time	9.71 (2.81)	8.37 (3.35)	8.71 (4.60)	9.15 (2.99)
Performance	8.05 (3.64)	6.17 (2.96)	6.30 (3.34)	7.69 (3.03)
Effort	10.25 (3.59)	8.60 (3.27)	9.62 (3.48)	10.57 (3.81)
Frustration	10.64 (2.96)	7.93 (3.71)	10.74 (4.07)	11.55 (3.78)

Note. B = Baseline. *n* = 16. Bonferroni *t* tests could not identify any significant differences between each pair of configurations within a subtask.

Table L-95

Summary of Bonferroni *t* tests for Subtask by Configuration Interaction on Evade ATGMs

Subtask	Comparison	*df*	*t*	(*p*)
	Configuration			
Mental	Base vs 1	15	.63	(.539)
	Base vs 3	15	.16	(.878)
	Base vs 4	15	.21	(.834)
	1 vs 3	15	-.79	(.442)
	1 vs 4	15	-.50	(.626)
	3 vs 4	15	.01	(.991)
Physical	Base vs 1	15	-.67	(.512)
	Base vs 3	15	-1.84	(.086)
	Base vs 4	15	-1.84	(.085)
	1 vs 3	15	-1.44	(.169)
	1 vs 4	15	-1.56	(.140)
	3 vs 4	15	-.28	(.785)
Time	Base vs 1	15	1.99	(.065)
	Base vs 3	15	1.04	(.316)
	Base vs 4	15	.74	(.472)
	1 vs 3	15	-.44	(.665)
	1 vs 4	15	-1.60	(.131)
	3 vs 4	15	-.50	(.624)
Performance	Base vs 1	15	2.90	(.011)
	Base vs 3	15	2.45	(.027)
	Base vs 4	15	.40	(.697)
	1 vs 3	15	-.31	(.764)
	1 vs 4	15	-3.33	(.005)
	3 vs 4	15	-2.99	(.009)

(*table continues*)

Subtask	Comparison	*df*	*t*	(*p*)
	Configuration			
Effort	Base vs 1	15	1.97	(.067)
	Base vs 3	15	.61	(.549)
	Base vs 4	15	-.40	(.693)
	1 vs 3	15	-2.21	(.043)
	1 vs 4	15	-2.53	(.023)
	3 vs 4	15	-1.52	(.150)
Frustration	Base vs 1	15	2.27	(.038)
	Base vs 3	15	-.10	(.923)
	Base vs 4	15	-.74	(.472)
	1 vs 3	15	-2.52	(.023)
	1 vs 4	15	-3.18	(.006)
	3 vs 4	15	-.82	(.423)

Note. * $p < .001$ to maintain overall error rate for the set of comparisons at .02 level of significance. Bonferroni *t* tests could not identify any significant differences between each pair of configurations within a subtask.

Table L-96

Means and Standard Deviations (in parentheses) for Subtask on Prepare and Send Contact Report

MD	PD	TD	P	E	F
8.45 (2.76)	6.01 (2.73)	8.37 (2.71)	5.70 (2.59)	9.31 (3.09)	8.22 (3.65)

Note. $n = 16$. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration. See Table L-97 for significant differences between each pair of subtasks.

Table L-97

Summary of Bonferroni t tests for Subtask on Prepare and Send Contact Report

Comparison	df	t (p)
Subtask		
MD vs PD	15	2.63 (.019)
MD vs TD	15	.21 (.836)
MD vs P	15	3.26 (.005)
MD vs E	15	-.83 (.420)
MD vs F	15	.21 (.837)
PD vs TD	15	-3.08 (.008)
PD vs P	15	.90 (.381)
PD vs E	15	-3.60 (.003)
PD vs F	15	-3.92 (.001)*
TD vs P	15	3.57 (.003)
TD vs E	15	-1.23 (.239)
TD vs F	15	.15 (.884)
P vs E	15	-3.57 (.003)
P vs F	15	-4.18 (.000)*
E vs F	15	.90 (.580)

Note. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration.* $p < .001$ to maintain overall error rate the set of comparisons at .02 level of significance.

Table L-98

Means and Standard Deviations (in parentheses) for Subtask by Configuration Interaction on Prepare and Send Contact Report

	Configuration			
Subtask	B	1	3	4
Mental	8.14 (2.09)	7.90 (2.94)	9.14 (3.74)	8.63 (3.43)
Physical	5.22 (1.85)	5.83 (3.21)	6.29 (2.81)	6.70 (3.58)
Time	8.43 (1.95)	7.60 (3.48)	8.68 (3.93)	8.77 (3.11)
Performance	5.72 (2.32)	5.30 (2.68)	5.61 (3.16)	6.17 (3.46)
Effort	8.65 (3.59)	8.93 (3.74)	9.62 (3.13)	10.00 (3.71)
Frustration	6.93 (2.95)	6.13 (3.17)	9.21 (5.48)	10.60 (6.03)

Note. $n = 16$. Bonferroni t tests could not identify any significant differences between each pair of configurations within a subtask.

Table L-99

Summary of Bonferroni t tests for Subtask by Configuration Interaction on Prepare and Send Contact Report

Subtask	Comparison	df	t (p)
	Configuration		
Mental	Base vs 1	15	.38 (.712)
	Base vs 3	15	-1.40 (.181)
	Base vs 4	15	-.72 (.483)
	1 vs 3	15	-2.09 (.055)
	1 vs 4	15	-1.91 (.075)
	3 vs 4	15	1.17 (.261)
Physical	Base vs 1	15	-1.27 (.222)
	Base vs 3	15	-2.78 (.014)
	Base vs 4	15	-2.70 (.017)
	1 vs 3	15	-1.14 (.273)
	1 vs 4	15	-2.27 (.039)
	3 vs 4	15	-.98 (.344)
Time	Base vs 1	15	1.13 (.278)
	Base vs 3	15	-.28 (.780)
	Base vs 4	15	-.48 (.639)
	1 vs 3	15	-2.08 (.055)
	1 vs 4	15	-2.06 (.057)
	3 vs 4	15	-.12 (.905)
Performance	Base vs 1	15	.63 (.538)
	Base vs 3	15	.21 (.837)
	Base vs 4	15	-.69 (.498)
	1 vs 3	15	-.58 (.570)
	1 vs 4	15	-1.35 (.197)
	3 vs 4	15	-1.92 (.074)
Effort	Base vs 1	15	-.35 (.730)
	Base vs 3	15	-1.20 (.249)
	Base vs 4	15	-1.85 (.084)
	1 vs 3	15	-.94 (.361)
	1 vs 4	15	-1.91 (.076)
	3 vs 4	15	-.58 (.572)
Frustration	Base vs 1	15	.89 (.386)
	Base vs 3	15	-1.98 (.066)
	Base vs 4	15	-2.42 (.029)
	1 vs 3	15	-3.24 (.006)
	1 vs 4	15	-3.72 (.002)
	3 vs 4	15	-1.29 (.423)

Note. * $p < .001$ to maintain overall error rate for the set of comparisons at .02 level of significance. Bonferroni t tests could not identify any significant differences between each pair of configurations within a subtask.

Table L-100

Means and Standard Deviations (in parentheses) for Subtask on Prepare and Send Spot Report

MD	PD	TD	P	E	F
8.60 (3.07)	5.92 (2.69)	8.28 (2.75)	5.73 (2.84)	9.30 (3.36)	8.29 (3.26)

Note. n = 16. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration. See Table 101 for significant differences between each pair of subtasks.

Table L-101

Summary of Bonferroni t tests for Subtask on Prepare and Send Spot Report

Comparison	df	t (p)
Subtask		
MD vs PD	15	2.85 (.012)
MD vs TD	15	.72 (.482)
MD vs P	15	3.20 (.006)
MD vs E	15	-.64 (.530)
MD vs F	15	.27 (.790)
PD vs TD	15	-3.24 (.006)
PD vs P	15	.40 (.697)
PD vs E	15	-3.47 (.003)
PD vs F	15	-4.02 (.001)*
TD vs P	15	3.38 (.004)
TD vs E	15	-1.27 (.223)
TD vs F	15	-.01 (.993)
P vs E	15	-3.33 (.005)
P vs F	15	-3.98 (.001)*
E vs F	15	.83 (.419)

Note. MD = mental demand; PD = physical demand; TD = time demand; P = performance; E = effort; F =frustration. * p < .001 to maintain overall error rate the set of comparisons at .02 level of significance.

Table L-102

Means and Standard Deviations (in parentheses) for Subtask by Configuration Interaction on Prepare and Send Spot Report

	Configuration			
Subtask	B	1	3	4
Mental	8.30 (2.21)	8.50 (3.48)	9.13 (4.45)	8.46 (3.28)
Physical	5.03 (2.05)	6.10 (3.37)	6.13 (3.17)	6.40 (3.12)
Time	8.40 (2.33)	7.53 (3.01)	8.58 (4.05)	8.61 (3.11)
Performance	5.67 (2.92)	5.37 (2.96)	5.75 (3.57)	6.15 (3.64)
Effort	7.60 (3.85)	9.07a (3.97)	9.52 (4.27)	11.02b (3.73)
Frustration	7.07 (3.34)	6.53 (3.22)	8.90 (4.60)	10.66 (5.71)

Note. B = Baseline. n = 16. Means in the same row with different letters differ, p < .001, Bonferroni t test.

Table L-103

Summary of Bonferroni t tests for Subtask by Configuration Interaction on Prepare and Send Spot Report

Subtask	Comparison	df	t (p)
	Configuration		
Mental	Base vs 1	15	-.29 (.774)
	Base vs 3	15	-.99 (.338)
	Base vs 4	15	-.24 (.814)
	1 vs 3	15	-.96 (.354)
	1 vs 4	15	.15 (.881)
	3 vs 4	15	1.09 (.292)
Physical	Base vs 1	15	-2.13 (.050)
	Base vs 3	15	-1.84 (.085)
	Base vs 4	15	-2.85 (.012)
	1 vs 3	15	-.06 (.954)
	1 vs 4	15	-.91 (.378)
	3 vs 4	15	-.47 (.647)
Time	Base vs 1	15	1.37 (.189)
	Base vs 3	15	-.26 (.796)
	Base vs 4	15	-.44 (.666)
	1 vs 3	15	-1.37 (.190)
	1 vs 4	15	-2.03 (.061)
	3 vs 4	15	-.04 (.969)
Performance	Base vs 1	15	.39 (.705)
	Base vs 3	15	-.12 (.904)
	Base vs 4	15	-.56 (.582)
	1 vs 3	15	-.64 (.532)
	1 vs 4	15	-2.13 (.050)
	3 vs 4	15	-.65 (.526)

(table continues)

Subtask	Comparison	df	t	(p)
	Configuration			
Effort	Base vs 1	15	-1.48	(.161)
	Base vs 3	15	-2.01	(.063)
	Base vs 4	15	-3.45	(.004)
	1 vs 3	15	-.53	(.601)
	1 vs 4	15	-5.26	(.000)*
	3 vs 4	15	-1.81	(.090)
Frustration	Base vs 1	15	.47	(.646)
	Base vs 3	15	-1.53	(.148)
	Base vs 4	15	-2.41	(.029)
	1 vs 3	15	-3.18	(.006)
	1 vs 4	15	-3.55	(.003)
	3 vs 4	15	-1.54	(.145)

Note. * $p < .001$ to maintain overall error rate for the set of comparisons at .02 level of significance.